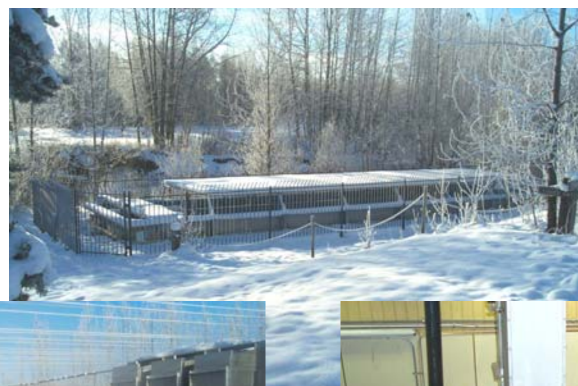
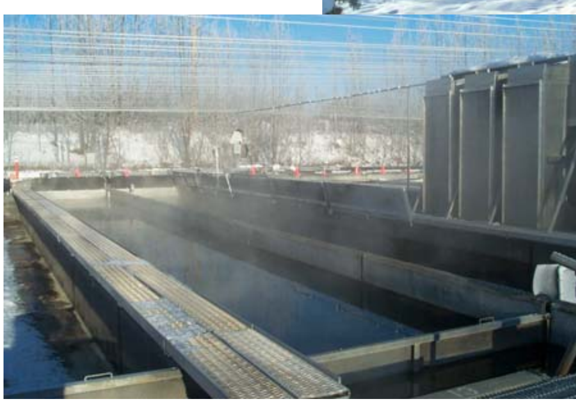
FISHERIES BIOENGINEERING SERVICES FOR HATCHERY EVALUATION AND WATER USE/WATER TREATMENT RECOMMENDATIONS

ELMENDORF STATE FISH HATCHERY ALASKA DEPARTMENT OF FISH AND GAME SPORT FISH DIVISION





MARCH, 2002

PREPARED BY:
THE CONSERVATION FUND
FRESHWATER INSTITUTE

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EXECUTIVE SUMMARY

Elmendorf State Fish Hatchery (SFH) is a sport fish enhancement hatchery that currently produces and stocks accelerated growth chinook salmon smolts and rainbow trout catchables into various sites in south-central Alaska. Through an agreement between the Alaska Department of Fish and Game (DF&G) and the Elmendorf Air Force Base, the hatchery uses the waste heat water supply from the base power plant while maintaining the power plant cooling pond and intake. The Alaska Department of Fish and Game, Sport Fish Division has operated Elmendorf SFH since the 1970's.

In September of 2003 the Fort Richardson Military Reservation power plant will be decommissioned as the reservation shifts to a decentralized heating system to achieve better overall energy efficiencies. This transition will result in the loss of the waste heat water supply for Fort Richardson SFH. This will have significant impacts for the current biological production in place at Fort Richardson SFH and Elmendorf SFH. Additionally, Elmendorf Air Force Base is currently reviewing its power plant for potential upgrade or decommissioning. The decision on the Elmendorf power plant will be made in late 2002. If this review results in the closing of the Elmendorf Air Force Base power plant then Elmendorf SFH would likely lose its source of heated water in 2005. Both of these issues will have significant impacts on hatchery production and future programming for the Alaska DF&G Sport Fish Division. Because of these impending changes the Alaska DF&G initiated an evaluation of both Fort Richardson SFH and Elmendorf SFH to assist in identifying needs and proposed solutions for their programs at the hatcheries. This report is the outcome of the evaluation done of the Elmendorf SFH and has identified five primary needs that exist at Elmendorf SFH:

Need #1. Preparation for a shift in production when Fort Richardson SFH loses its heated water supply

Need #2. Upgraded office and egg incubation facilities

Need #3. Upgraded facilities for fish passage, public viewing, education, and outreach

Need #4. Develop an effluent treatment and solids management plan to meet EPA's new guidelines for flow through salmonid hatcheries

Need #5. Preparation for a loss of heated water supply in the event that the Elmendorf Air Force Base power plant is decommissioned

The most immediate need and recommendation addresses a proposed shift in production between Fort Richardson SFH and Elmendorf SFH due to Fort Richardson SFH losing its source of heated water. It is recommended that all catchable fish production shift to Elmendorf SFH and the chinook salmon smolt production at Elmendorf SFH be moved to Fort Richardson SFH. This takes advantage of the existing waste heat supply at Elmendorf SFH. This solution will allow the Alaska DF&G to meet its current production goals as long as Elmendorf SFH has a source of waste heat. However, the potential exists for the closing of the Elmendorf power plant and the loss of the waste heat water supply for Elmendorf SFH. Because of this possibility it is recommended that the planning process for a new hatchery that would replace Fort Richardson SFH begin. Once Fort Richardson SFH is closed Elmendorf SFH would then shift to cold water production of smolts for stocking at local stocking sites. This would allow Elmendorf SFH to meet the smolt production required and also take advantage of its location in an urban setting for public outreach and education. Elmendorf SFH's location is a unique opportunity to easily reach out to a large population base and provide education about the natural aquatic environment, Pacific salmon, and the activities of the Alaska Department of Fish and Game to conserve these natural resources. It is recommended that this opportunity be maximized and facilities to accomplish this be constructed around improvements to the fish ladder.

REVIEW OF EXISTING CONDITIONS

Hatchery Background Information

Contacts

Address

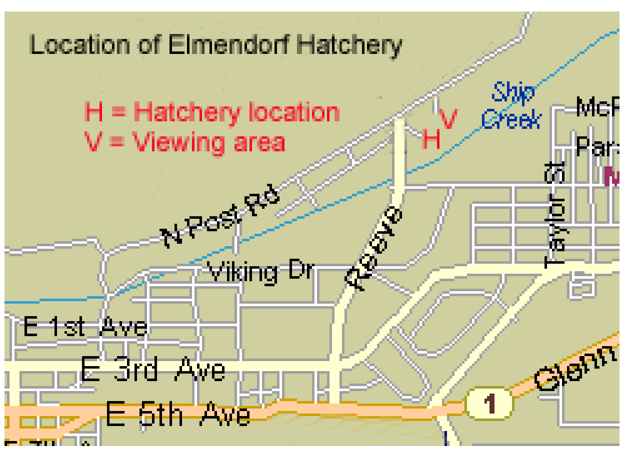
Elmendorf State Fish Hatchery
Sport Fish Division, Alaska Department of Fish and Game
941 North Reeve Blvd.
Anchorage, AK 99501
(907) 274-0065
(907) 272-1528 fax
email: darrell_keifer@fishgame.state.ak.us
website: http://www.sf.adfg.state.ak.us/region2/hatchery/html/elmhatch.stm

Staff and organization

Darrell Keifer	Hatchery Manager (1980–Present)
Bob Pence	Assistant Hatchery Manager
Bob MacFadden	Biological Technician
Robert Holmes	Maintenance Mechanic
Elizabeth Whitmore	Fish Culturist

Location

Elmendorf SFH is located in Anchorage, Alaska at latitude N 61º 13’ 717” and longitude W 149º 50’ 088”. From the Glenn Highway (Route 1 W) take a left onto North Reeve Boulevard and the hatchery is on the right. Elevation at the hatchery is approximately 90 ft above sea level.



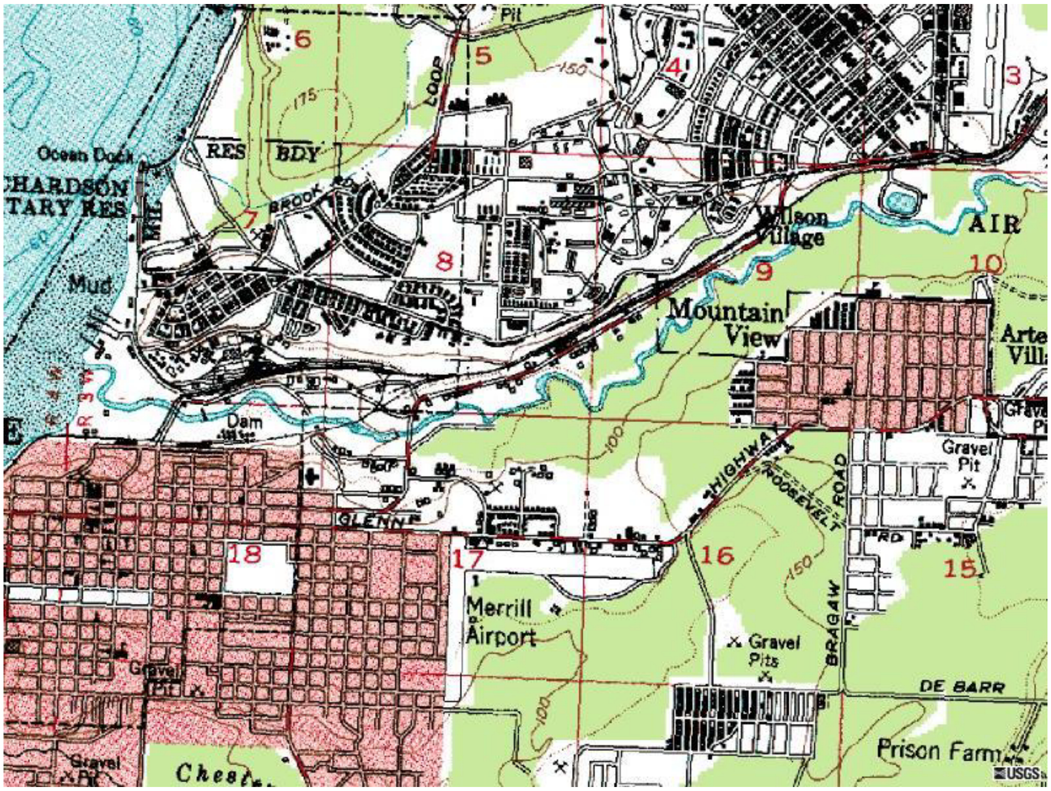


Figure 1. USGS topographic map of the area surrounding Elmendorf SFH

Figure 2. USGS aerial photograph of Elmendorf SFH

Facility Overview

Elmendorf SFH is a sport fish enhancement hatchery that currently produces and stocks accelerated growth chinook salmon smolts and rainbow trout catchables into various sites in south-central Alaska. Through an agreement between the Alaska Department of Fish and Game (DF&G) and the Elmendorf Air Force Base, the hatchery uses the waste heat water supply from the base power plant while maintaining the power plant cooling pond and intake. The Alaska Department of Fish and Game, Sport Fish Division has operated Elmendorf SFH since the 1970's. Prior to state operation of the Elmendorf hatchery, the U.S. Air Force operated the hatchery to grow and stock rainbow trout in lakes on Elmendorf Air Force Base to create a recreational fishery for base personnel. Original hatchery construction was wooden ponds, taking advantage of the waste heat water supply returning from the base power plant. In 1978 the Alaska DF&G constructed the main hatchery raceways, water intake building, and pipelines.

Throughout the period from 1978 to 1999 Elmendorf SFH raised a combination of chinook salmon, coho salmon, and rainbow trout. In the 1990's the hatchery primarily raised chinook and coho salmon smolts. The fish raised at Elmendorf SFH are stocked into various rivers and lakes according to the Alaska DF&G *Statewide Stocking Plan for Recreational Fisheries*. Fish produced and stocked from Elmendorf SFH are derived from remote egg takes of wild salmon returning to spawn in rivers in Alaska. Swanson River-strain rainbow trout are also raised at Elmendorf SFH which are derived from broodstock maintained at Fort Richardson SFH. Additionally, Elmendorf SFH serves as a broodstock collection, maturation, egg take, and central incubation facility for coho and chinook salmon.

Elmendorf SFH is funded by a combination of federal and state funding. The Federal Aid for Sport Fisheries Restoration Act (Dingell-Johnson, Wallop-Breaux) supplies 75% of the hatchery funding while the Alaska DF&G supplies 25% of the funding. The total yearly budget for Elmendorf SFH is approximately $500,000 with a full-time staff of 5 and some seasonal part-time staff.

Surrounding Land Use and Watershed Issues

General Description

Elmendorf SFH is located within the Anchorage Watershed (USGS Cataloging Unit 19020401). The Anchorage Watershed is the eight-digit hydrologic unit code watershed as delineated by the USGS, however on a local basis the hatchery lies in the Ship Creek Watershed. Figure 3 shows a map of the Ship Creek Watershed.

Key Watershed Issues

There are four dams/spillways currently on Ship Creek. Three are associated with power plant water supplies and one with a municipal drinking water supply.

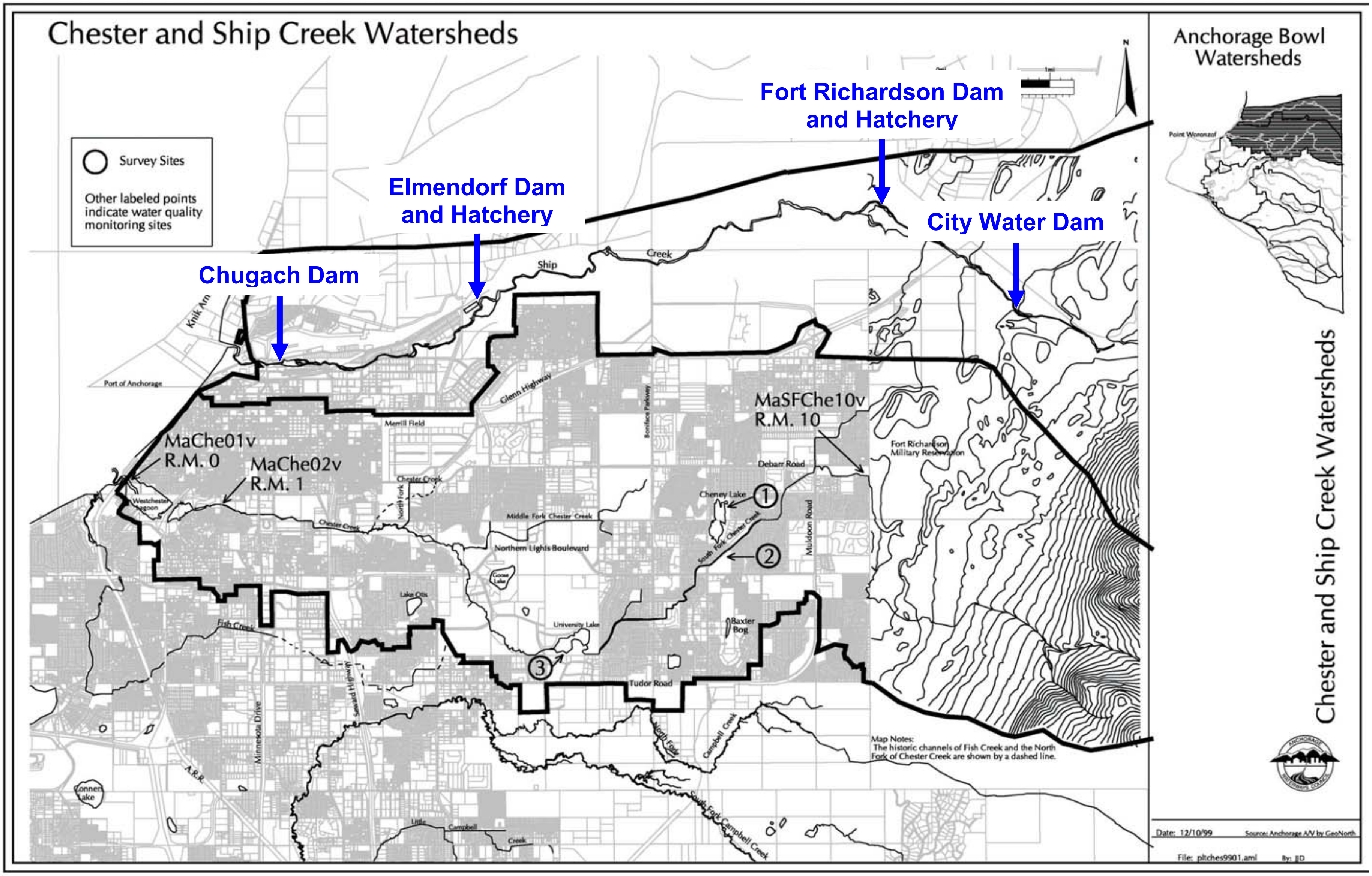


Figure 3. Map of the Ship Creek Watershed showing the location of the four dams on Ship Creek

There is a large dam to impound cooling water at the inactive Chugach Steam and Electric power plant that is located within one mile of where Ship Creek flows into Cook Inlet (Figure 3). The Chugach Dam is approximately 5.5 ft high and was constructed within the intertidal area of Ship Creek. The Chugach Dam has a fish ladder that was constructed in 1970. Because the Chugach Dam replaced most of the estuary, salmon smolts that pass down the fish ladder go immediately from a freshwater environment to a saltwater environment and adult salmon entering the ladder go immediately from a saltwater environment to a freshwater environment. Some claim that this forced and abrupt transition makes this the most destructive dam to anadromous fish on Ship Creek, as adult salmon preparing to migrate upstream and salmon smolt migrating to the ocean have little time to adapt to the new salinity levels. This dam may have eliminated smelt and white fish in Ship Creek. However, Nation's Energy Company had expressed an interest in re-activating this power plant and utilizing this dam.

There are also two dams/spillways at each state fish hatchery. These dams were built to supply cooling water for the power plants at the Elmendorf Air Force Base and the Fort Richardson Military Reservation. The hatcheries were built next to the power plants to take advantage of the waste heat discharged from these power plants. The Elmendorf Dam was initially built in 1942 and is located approximately 2.3 miles from the mouth of Ship Creek. The Elmendorf Dam was rebuilt most recently in 1983 as a two-tiered, 14.2 ft high, sheet-pile dam. This dam has a two-tiered fish ladder that has never been opened and virtually all fish passage upstream of the dam has been blocked except during high water events when a few king salmon can pass the two-tiered dam and spawn upstream. One proposed plan to restore fish passage in Ship Creek calls for rebuilding the fish ladder at Elmendorf SFH in order to enhance salmon passage while also providing an opportunity for public education and outreach at the hatchery (See the Identified Needs and Recommendations section for more details). The Fort Richardson Dam was built in 1953 and this dam may be low enough for adult salmon to jump, if the salmon were able to migrate that far up Ship Creek.

The fourth dam on Ship Creek was built in 1941 and rebuilt in 1953 approximately 12 miles from the mouth of Ship Creek. This large 40 ft tall dam was constructed in order to supply drinking water to Anchorage and to both military bases, but is now only being used to supply water to both military bases.

These four dams on Ship Creek have impacted the natural fisheries in Ship Creek by:

- restricting and blocking fish passage;
- reducing the intertidal mixing area and the size of the estuary zone at mouth of Ship Creek;
- producing man-made pools that have eventually filled in with sediment and that over the years have limited the transport of sands and gravels to the mouth of Ship Creek at Cook Inlet, which has had some affect on this estuary environment.

Also, three of the dams were constructed to supply power plants with cooling water flows that when discharged to Ship Creek create a zone of unnaturally warm water that may be a barrier to fish passage and also changes environmental conditions in Ship Creek.

The local watershed group, the Anchorage Waterways Council, would like to see the first three dams removed from Ship Creek to restore the creek to conditions that would support more natural salmonid fisheries.

The habitat division of the Alaska Department of Fish and Game is also in support of dam removal. Ship Creek is the second most popular fishery in Alaska and several private non-profit, federal, or state agencies may be willing to supply money and/or manpower to restore the Ship Creek drainage to more natural conditions.

Agriculture

Elmendorf SFH is located in an urban watershed with little or no agriculture.

Industry

Elmendorf Air Force Base is immediately adjacent to and upstream of the hatchery. This is an active Air Force base hosting the 3rd Wing, the Eleventh Air Force, Alaska NORAD, and the Alaskan Command. Elmendorf Air Force Base has at least two large runways. The hatchery is in an urban industrial area with a former junkyard across the street that was designated a Superfund site (dioxin pollution) and has been sealed off. Also close-by is a steel plant, a gravel yard, and an asphalt recovery plant. All industrial development is located downstream of the hatchery and hatchery water intake.

Development

There appears to be little residential/urban development in the immediate area around the hatchery, however the hatchery is in the city limits and within a few miles of substantial commercial development and city streets. In addition to heavy local commercial development there are also two golf courses in the watershed. One of these golf courses is located across Ship Creek from the hatchery. The golf course manager has indicated that they fertilize the course 1–2 times a year. Elmendorf Air Force Base water quality data has shown that the nitrogen in the runoff from the golf course is insignificant in comparison to the nitrogen coming from the Air Force base deicing.

Upstream

Upstream of the hatchery are two golf courses and the Elmendorf Air Force Base. In the past the runways at the Air Force base were cleaned/deiced with urea. The runoff from the runways is directed away from Ship Creek, and therefore away from the hatchery intake. However, the snow pack around the runways will contain whatever chemical the runway is cleaned with and during snow melt the chemicals can runoff to a bog and then Ship Creek. In the past this has added substantial nitrogen loading to Ship Creek. Currently the Air Force base has switched from urea to an acetate-based chemical for cleaning/deicing the runways.

Stakeholders

The local watershed group is the Anchorage Waterways Council (AWC). This group is based in Anchorage and has an office and paid staff including an executive director. In 2000 the AWC had $121,000 in income with the majority of funds coming from the U.S. Environmental Protection Agency 319 grant program ($76,000). The AWC presents their mission on their world wide web site (http://www.anchwaterwayscouncil.org/index.htm) as the following:

> The Anchorage Waterways Council (AWC) is a non-profit organization comprised of residents who believe that Anchorage's waterways and related habitats are a valuable resource. The AWC organized following the first Creek cleanup effort in 1984.
>
> The scope of the AWC is Municipality-wide, from Peter's Creek to Portage Glacier and includes all types of waterways -- rivers, lakes, streams and wetlands. The AWC is committed to preventing further degradation of our waterways, enhancing our waterways through public involvement and education, ensuring safe and productive aquatic and riparian habitat for fish and wildlife, and monitoring activities that affect our waterways.

In partnership with other local environmental groups the AWC started a water quality monitoring program in 1999. This Citizen's Environmental Water Quality program relies on a network of volunteers to take physical and chemical baseline data in seven creeks in the Anchorage area. There are plans to expand the program to cover more water bodies and also perform bioassessment studies.

In addition to the Citizen's Environmental Water Quality program the AWC sponsors creek clean-ups, publishes a quarterly newsletter for its members, and performs environmental education and outreach through sponsored-events like its annual meeting. The AWC also has an active program that seeks to remove the three lower dams from Ship Creek. In November 2001 a coordinator was hired to lead the AWC efforts to get the lower dams removed from Ship Creek.

Membership in the AWC costs $20 for an individual membership, $30 for a family membership, and $125 for a basic corporate membership. Contact information for the AWC follows:

Anchorage Waterways Council
P.O. Box 241774
Anchorage, Alaska 99524-1774
(907) 277-9287
email: awc@alaska.net
Office Location: 619 E. Ship Ave, Suite 319
Executive Director: Holly Kent

Water Supply

Source

Elmendorf SFH has three sources of water supply:

- Raw Ship Creek water from an intake structure
- Heated Ship Creek water returned from the Elmendorf Air Force Base power plant
- Well water from two wells

Ship Creek water is the predominant water source accounting for 4,000–7,500 gpm of water use at the hatchery. The wells are both located on hatchery property and are only used occasionally.

Surface

Ship Creek water is diverted into a concrete channel and passed through an inclined trash rack that incorporates vertical bars spaced on approximately 4 inch centers. This bar rack requires manual cleaning to remove debris and prevent clogging of the intake.

Figure 4. Intake diversion channel and bar rack

Raw Ship Creek water flows by gravity into the influent water treatment building where it is filtered by a mechanical traveling screen to remove leaves and debris. Filtered water is directed to the Elmendorf Air Force Base power plant cooling pond and used for hatchery culture water after blending for temperature. The screened Ship Creek water supplied to the Air Force Base is used for cooling purposes at their power plant. This water is returned to Elmendorf SFH at a temperature of 20–21ºC. The return heated water is used in the intake building to temper the cold Ship Creek water to a temperature between 7–14ºC for fish culture.

The hatchery maintains the cooling pond for the Elmendorf Air Force Base power plant up to the pump intake for the power plant. In the winter the hatchery must maintain the temperature in the cooling pond at a minimum of 5–6ºC. This requires directing heated water to the cooling pond from the heated return line.

Well

There are two wells available for operation at the hatchery. Well #1 is 140 ft deep and consistently supplies 320 gpm of water at 3.8–4.4ºC. This well is used for egg incubation purposes and the filling of fish transport trucks. Also, Well #1 may be used for production in March when Ship Creek water production is at its lowest point. Well #2 is 230 ft deep and supplies 60 gpm. This well is rarely used.

Surface Water Quantity

The U.S. Geological Survey (USGS) maintains an active stream-gage station on Ship Creek located upstream of Elmendorf SFH. The USGS station 15276000 is located at latitude N 61º 13’ 32” and longitude W 149º 38’ 06”. The datum of the stream gage is at 490 feet above sea level. Figure 5 shows the location of this station.

a. b.

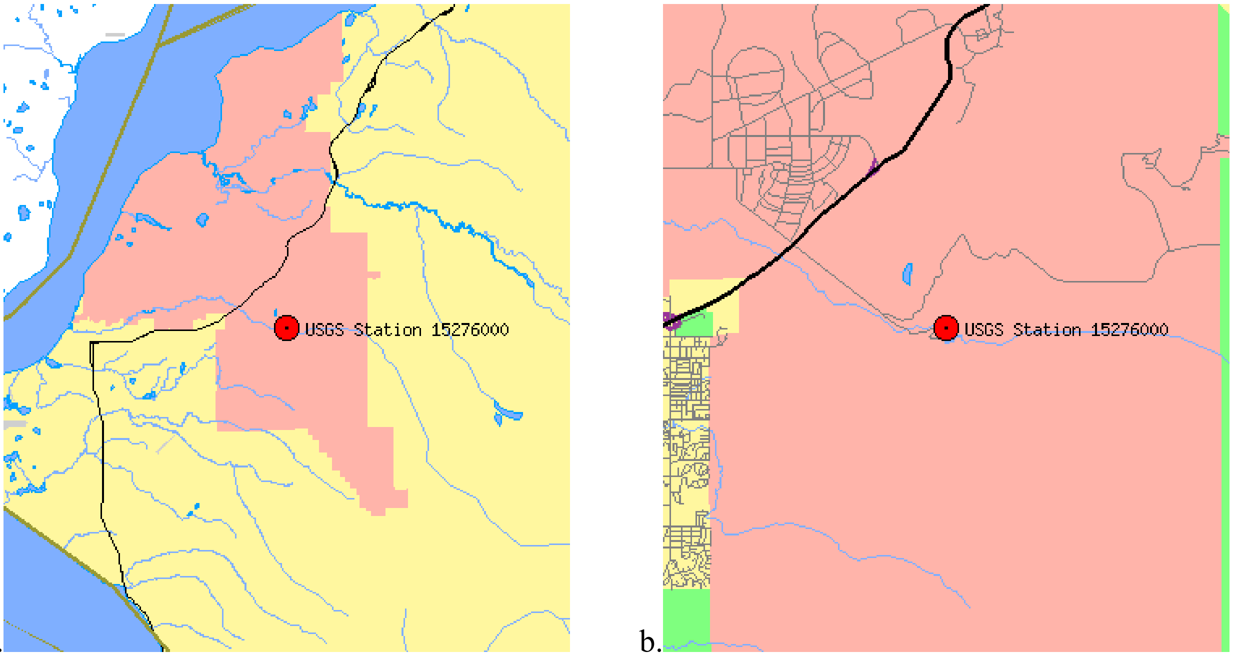


Figure 5. Location of the Ship Creek USGS Stream-Gage Station: a. wide view and b. close-up

Data from this stream-gage station are available for stream flow of Ship Creek. Ship Creek displays a consistent yearly pattern of stream flow that is discussed in the next section.

Seasonal

The Ship Creek water source is seasonal in quantity and temperature. The USGS stream-gage station shows that the maximum flow of over 450 cubic feet per second (cfs) occurs in June and flow declines until it reaches a minimum of 16 cfs in March. Water flow is still only 24 cfs in April and 168 cfs in May before the maximum in June. Figure 6 charts the monthly mean stream flow from the USGS data on record (1946–1999) showing this average yearly fluctuation. Figure 7 shows USGS daily stream flow data for the period from 1994–1999, which illustrates the consistency of this yearly fluctuation.

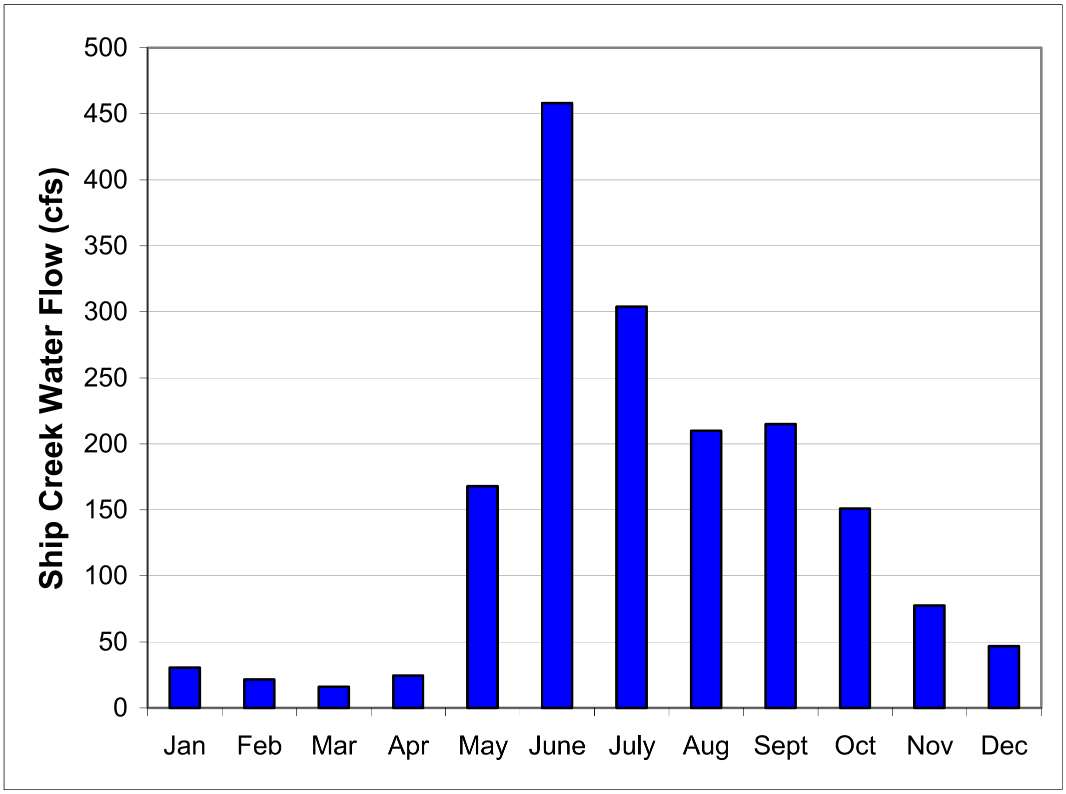


Figure 6. 1946–1999 monthly mean Ship Creek flow in cubic feet per second (cfs)

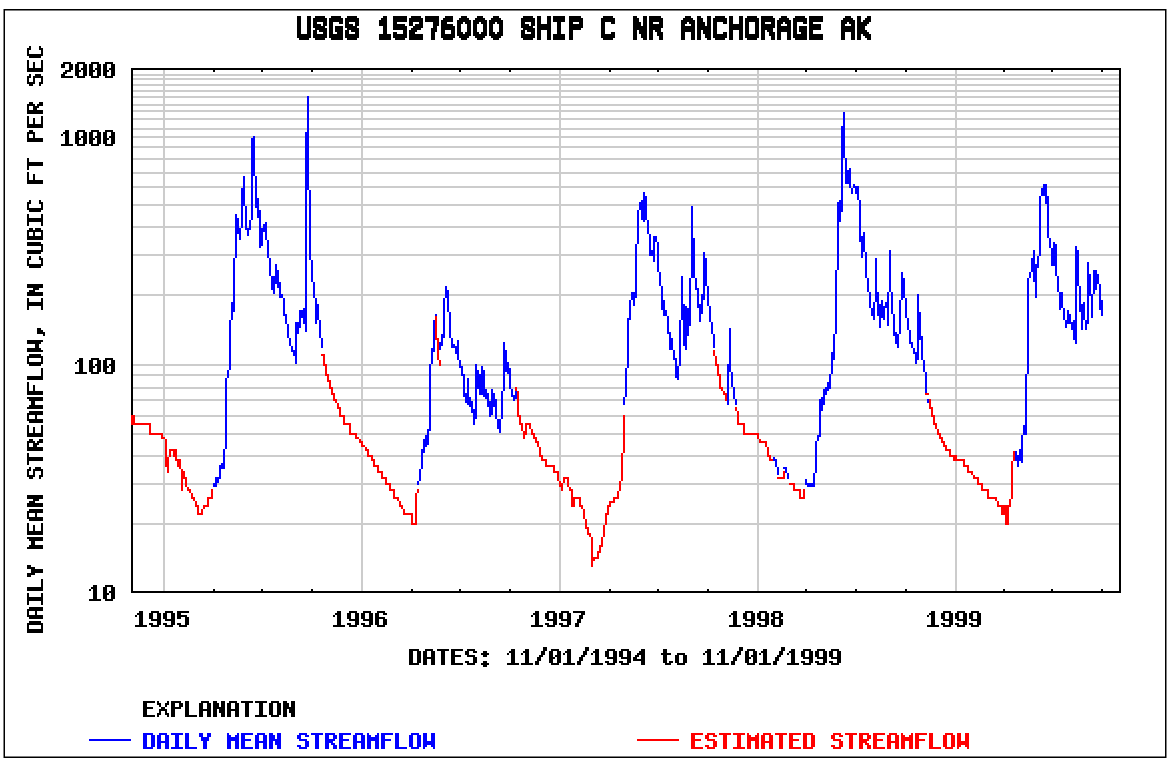


Figure 7. 1995–1999 daily mean Ship Creek flow in cubic feet per second (cfs)

Surface Water Quality

Ship Creek also fluctuates in temperature over the course of a year as would be expected for a flowing surface water. Elmendorf SFH staff estimate that the temperature varies from 0.5ºC in December, January, and February to 10.2ºC in July. Figure 8 shows the estimated monthly mean Ship Creek water temperatures.

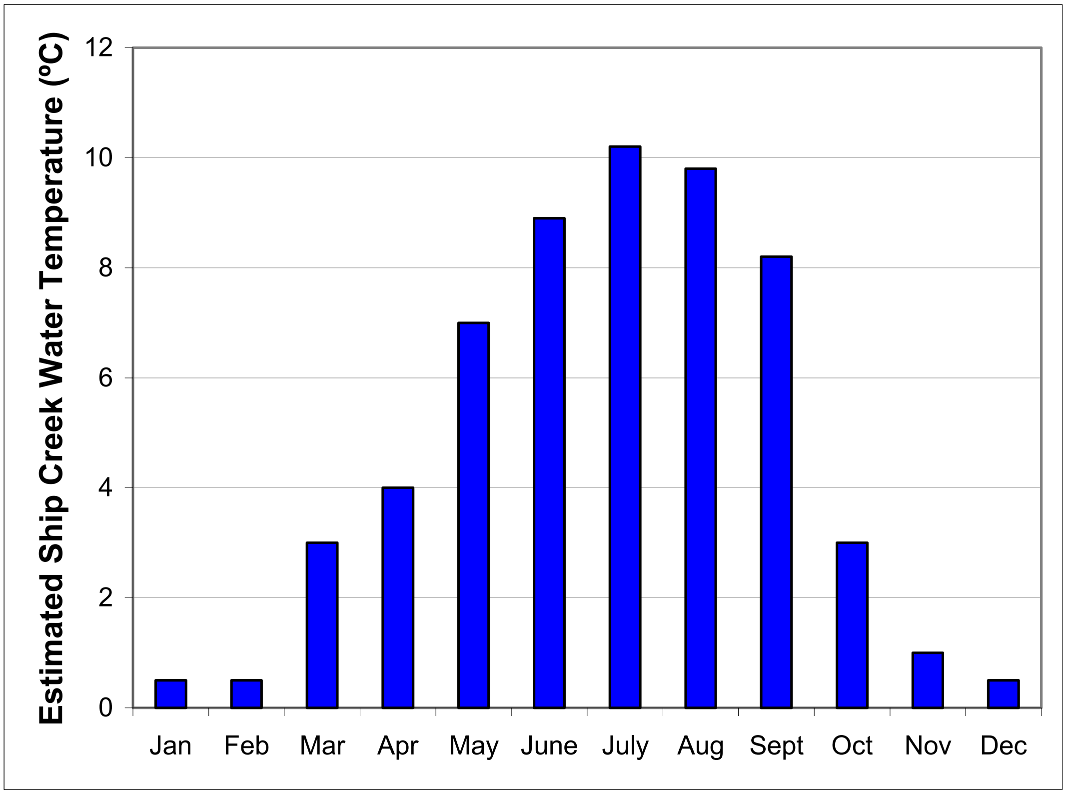


Figure 8. Estimated monthly mean Ship Creek water temperature in degrees Celsius

Hatchery water quality records for Ship Creek exist from a sampling event in April 1991. In this water quality monitoring event Ship Creek water was sampled from five locations: above Fort Richardson SFH (SP #1), at the effluent from Fort Richardson SFH (SP #2), between Fort Richardson and Elmendorf SFH (SP #3), above the golf course adjacent to Elmendorf SFH (SP #4), and below the golf course (SP #5). Figure 9 illustrates the approximate sample point locations in relation to Fort Richardson and Elmendorf SFH. Table 1 presents the results of the water quality analysis. The data shows a marked increase in conductivity (88%), alkalinity (143%), and magnesium (293%) after Ship Creek passes the Air Force base north/south runway. Additionally, nitrate/nitrite increases 3,100% after Ship Creek passes the golf course.

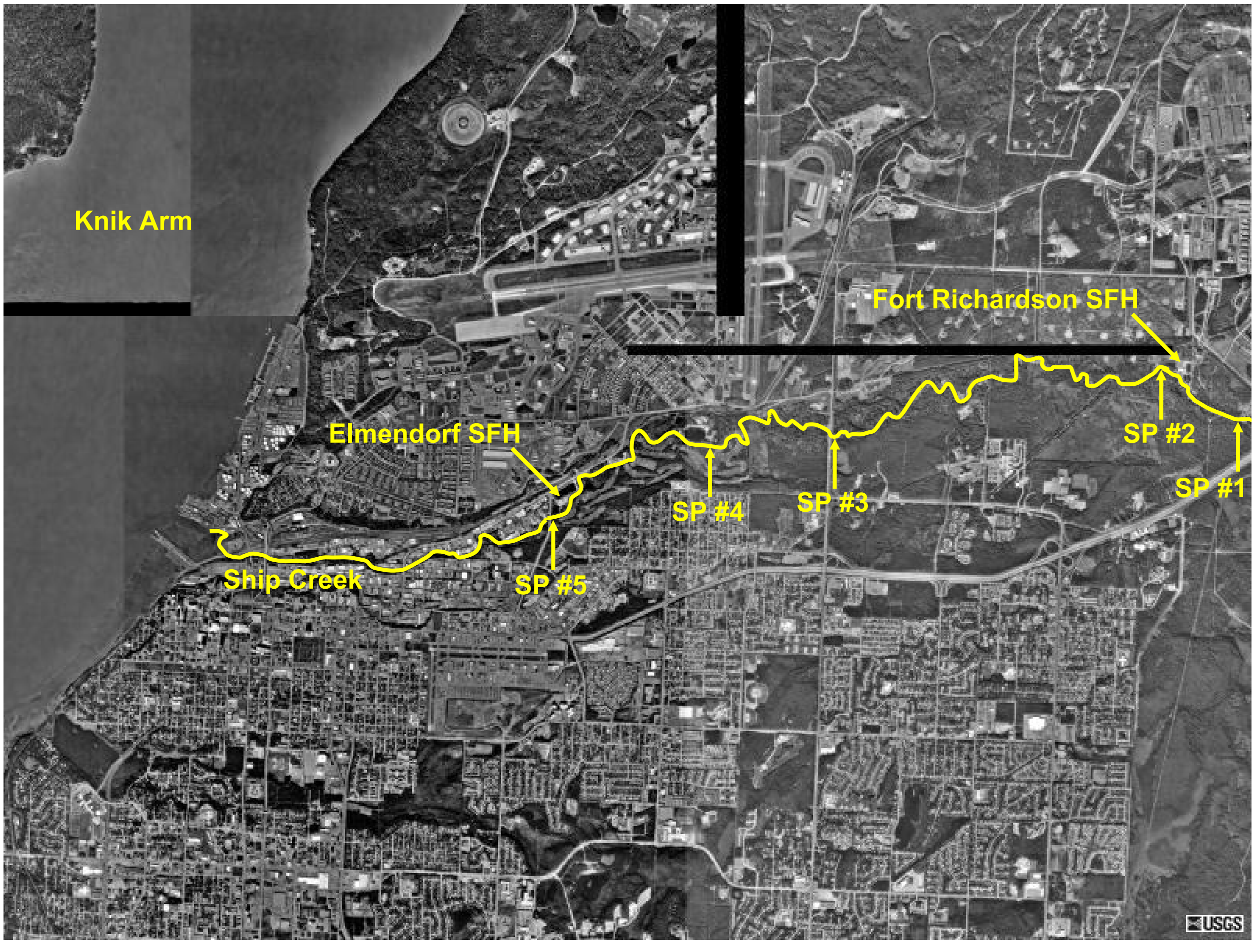


Figure 9. Approximate location of water quality sample points within Ship Creek in April 1991

Parameter	SP #1	SP #2	SP #3	SP #4	SP #5
Conductivity (µmhos/cm)	160	180	163	306	335
pH	7.7	7.6	8.8	7.2	7.9
Alkalinity (mg/L)	61	65	60	146	141
Turbidity (NTU)	2.0	1.8	1.4	0.6	0.3
Color (Pt units)	6	4	5	3	3
Calcium (mg/L)	20.2	23.8	21.1	21.2	30.8
Magnesium (mg/L)	3.7	3.0	3.0	11.8	9.7
Total Iron (µg/L)	42	36	30	29	32
Total P (µg/L)	2.4	174.4	33.9	2.7	1.5
TAN (µg/L)	4.4	268.9	12.2	25.3	5.9
Nitrate/Nitrite (µg/L)	298.6	378.2	326.1	113.8	3668
Reactive Silicon (µg/L)	3639	3558	2591	6320	5620

Table 1. Water quality analysis for Ship Creek from April 1991

Treatment Processes

Type/Capacity

Ship Creek water flows by gravity from the diversion channel into the water intake building. This water flow first passes through a mechanical traveling screen filter (FMC Link Belt) and into a sump. The traveling screen filter removes leaves and debris that passed trough the bar rack in the diversion channel. A pipe collects this screened water flow and passes the water through a pneumatic coldwater temperature valve that is currently not in use. A warm water temperature-mixing valve, located on the hot water (20–21ºC) line returning from the power plant, is used to blend the hot water and cold water flows to maintain a programmed warm water temperature set-point of between 7–14ºC. This blended warm water flow is sent to the degassing building. Some of the hot water is also directly sent to the degassing building. The remaining hot water supply from the power plant is either sent directly to Ship Creek or is blended into the cooling water pond in order to prevent the cooling water pond water temperature from dropping below 5–6ºC. Additionally, ambient temperature water that has been filtered in the traveling screen filter can be directed to the broodstock raceways during summer operation.

Hot water and blended warm water flow to separate floor sumps in the degassing building. The blended warm water is pumped with a three-pump array of vertical turbine pumps to a custom wedgewire screen filter that was constructed and installed by hatchery staff in 2000. The wedgewire screen filter directs water from the surge tank at the back of the unit over a horizontal weir so that the flow travels over and through industrial wedgewire inclined stainless steel panels. The slot size in the wedgewire panels is 0.063 inches. Particulates captured on the screen panels slide down to the bottom end of the panels and are caught in a trough at the base of the unit. The water depth below the screen panels is maintained with an overflow. Water passing over this overflow is returned to the pump sump. The aluminum box beneath the wedgewire screen panels also serves as a head box supplying eight vacuum degassing units. Pumping for this part of the influent water treatment has been estimated to cost $0.01 per 1,000 gallons.

The eight vacuum degassers are screenless towers, 9 feet tall and 30.6 inches in diameter, constructed of 1/8 inch thick 5052 aluminum. Water enters the towers through an 8 inch diameter inlet and flows through a nozzle directly below the inlet, which breaks up the water for gas stripping. There is a 1 inch air inlet on the side of the column and a 1 inch air outlet on the top of the unit connected to a regenerative blower that supplies a vacuum. One 1.5 horsepower regenerative blower (AREA, Model DR505) operates all eight degassing columns. Each column handles 1,200 gpm and will create its own vacuum when flows are over 800 gpm. Hydraulic loadings at these flowrates are 235 gpm/ft^2 and 157 gpm/ft^2, respectively. Previous operation was without the regenerative blower. With the regenerative blower in operation the towers are operated with between 40–60 inches of water vacuum. The regenerative blower makes regulating the vacuum within the tower straightforward, because the vacuum can be simply controlled by adjusting the proportion of valve opening on the air inlet side to each column. Under normal hatchery operation with blended warm water (TGP = 110%), the towers are operated with 40 inches of water vacuum to lower the total gas pressure (TGP) to approximately 98–100% after treatment. Dissolved oxygen after treatment is 100% of saturation.

The vacuum degassers are set within a sump that provides head pressure for the raceways. There is no overflow within the pump sump. Therefore, if a pump fails or if the pumps are turned off, water will overflow the top of the pump sump and will flow onto the floor of the building and out of the building. Also, there is no overflow from the vacuum degasser sumps except for the supply line to the raceways.

The hot water line from the intake building coming into the degassing building supplies water to the hot water sump. Two vertical turbine pumps were installed to lift the hot water to supply a pair of vacuum degassing columns. These vacuum degassing columns are 11 feet tall and 30.6 inches in diameter constructed of 1/8 inch thick 5052 aluminum and have an 8 inch inlet. They are operated at 60 inches of vacuum to treat 115% TGP down to acceptable levels. Otherwise, these vacuum columns are similar to the eight vacuum degassing columns that are used to treat the warm water flow.

After degassing, the warm water and hot water supplies are piped to the production raceways and to the hatchery building. The hot water supply can be directed to different points within the concrete production raceways and to the aluminum raceways that typically receive third pass water flow.

Figure 10. FMC Link Belt traveling screen filter at the intake building

Figure 11. Vertical turbine pumps supplying the inclined wedgewire screen filter

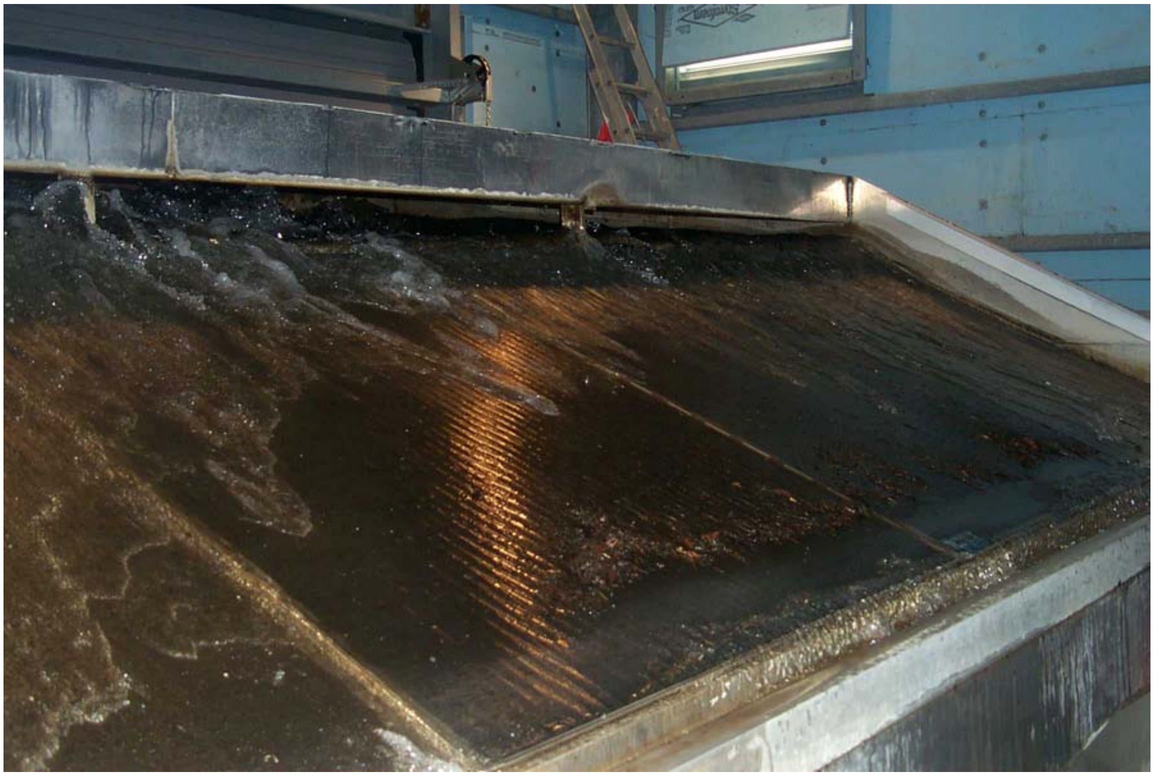


Figure 12. Wedgewire screen filter above the vacuum degasser columns

Figure 13. Vacuum degasser columns below the wedgewire screen filter

Process flow diagram

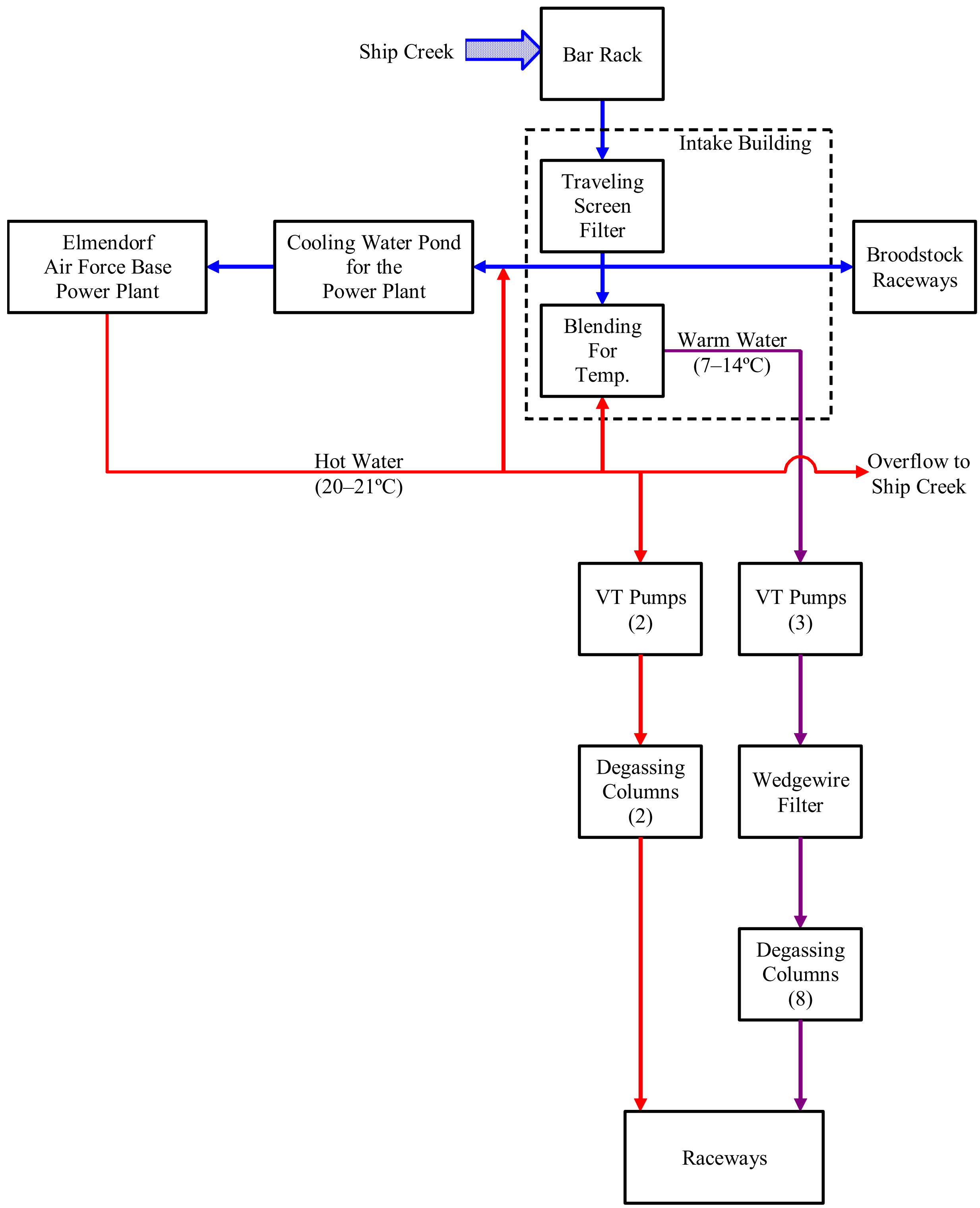


Figure 14. Influent water treatment process flow diagram

Facility Design

Elmendorf SFH is a serial water reuse facility with linear raceway rearing units. Ship Creek water and heated power plant return water is blended to provide culture water for the raceways with the capacity to use a portion of the culture water in three successive passes. However, the majority of the fish production occurs in the first and second-pass raceways. Figure 15 illustrates the overall physical layout of Elmendorf SFH.

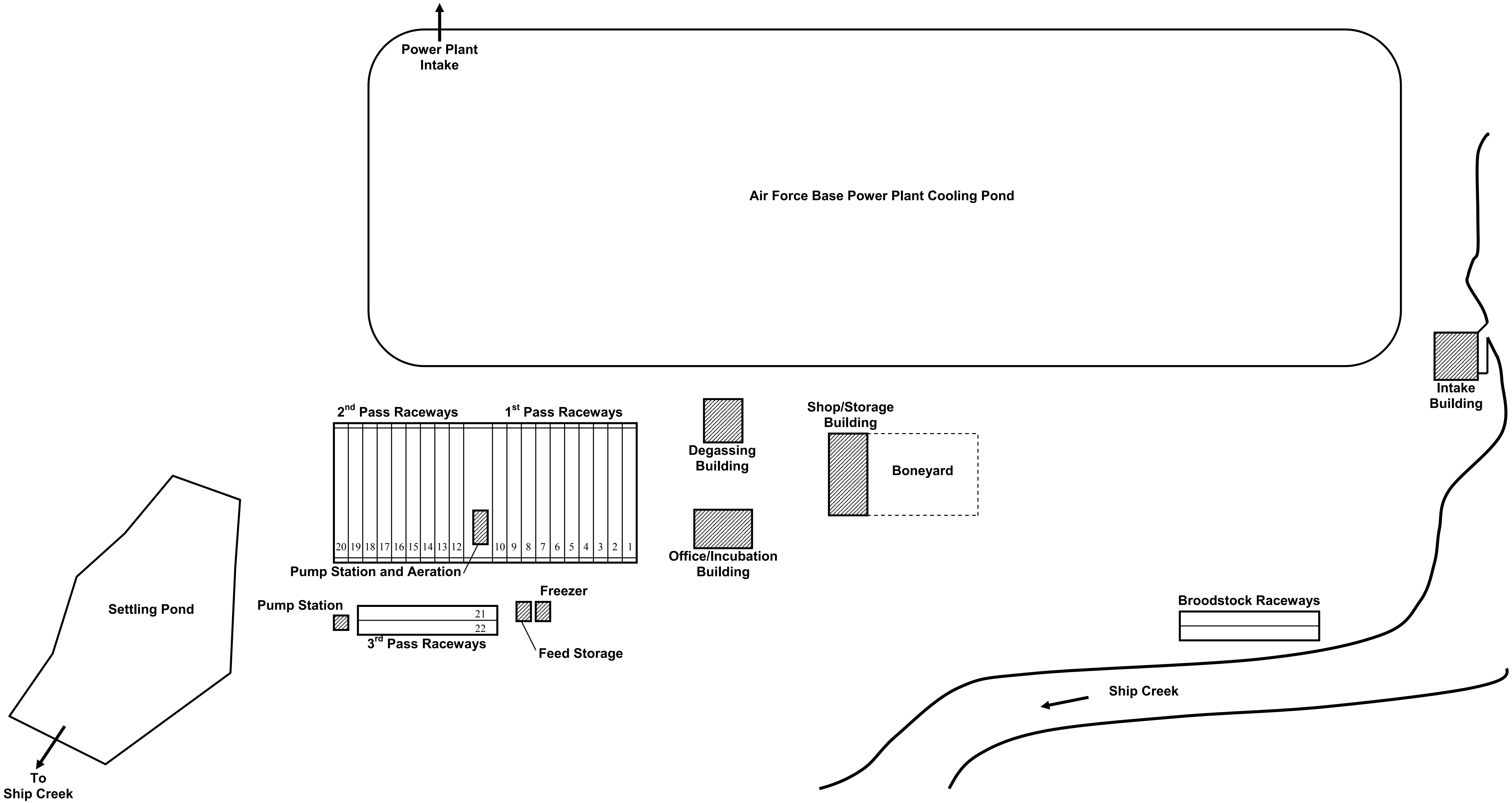


Figure 15. Overall Layout of Elmendorf SFH

Broodstock

Elmendorf SFH has a pair of aluminum raceways located immediately adjacent to Ship Creek for holding chinook and coho salmon trapped on Ship Creek in June and July of each year as broodstock. Each raceway is 8 feet wide and 90 feet long with 78 feet available for fish culture between the inlet and outlet screens. These raceways are 4 feet deep but are typically operated with 3 feet of water depth, which yields an available fish culture volume of 1,900 ft^3. Ship Creek water is supplied to these raceways from the water intake building and their discharge empties directly into Ship Creek.

Figure 16. Aluminum raceways used for holding salmon broodstock trapped on Ship Creek

Hatchery

The office/incubation building houses the egg incubation system. This system consists of eighteen standard 16-tray Heath stack incubators. The top tray in each stack is not used because of mixing and turbulence leaving 15 useable trays in each stack. This results in a total of 270 useable trays for incubation. Pumps in the office/incubation building provide degassed warm water to the hatching system through a temperature mixing valve, which blends cold well water (3.8–4.4ºC) with the warm water (7–14ºC) to maintain the desired hatching temperature of approximately 7ºC. Blended water is then directed to vacuum degassing columns located above each group of 16-tray incubator units. Water exiting the degassing columns enters an aluminum head trough above the 16-tray incubator units.

Figure 17. Incubation system with degassing columns, head troughs, and Heath stacks

Growout

Elmendorf SFH uses 19 concrete raceways and two aluminum raceways for fish production. All concrete raceways can be operated in a single-pass water use pattern. Alternatively, ten of the raceways can be used in a first-pass configuration with their effluent pumped by three vertical turbine pumps through open degassing columns and supplied to the head of the second 9 raceway units for second-pass serial reuse of the water. In this configuration the maximum water reuse flow that can be supplied to the second-pass raceways is 5,500 gpm. Each concrete raceway is 10 feet wide and approximately 68 feet long with 60 feet available for fish culture between the influent and effluent screens. The raceways are normally operated with 3 feet of water depth. However, the last 10 feet of each raceway has a lower bottom resulting in a water depth of 4.5 feet in this "kettle" section. Each raceway has an available fish culture volume of 1,800 ft^3 and receives between 400–700 gpm of water with a normal flow of approximately 550 gpm. These raceway water flows typically exchange each raceway culture volume approximately twice per hour.

The normal flow of 550 gpm results in a water velocity of 1.25 cm/s within each raceway. This low velocity allows uneaten fish feed and fish feces to settle within the raceways. Therefore the raceways are swept (with fish in the tank) and flushed once per week. The cleaning flow is directed out of the raceways through a floor drain at the deep end of the raceway and then flows to the settling pond.

The concrete raceways have been coated to repair cracks and pitting with an epoxy which has worked relatively well. During this rehabilitation the raceway's concrete surfaces were prepared with a waterproofing coating, Thoroseal® (Irish Roofing Felts, Dublin, Ireland) and then coated with an epoxy, Thermal-chem (Thermal-chem, Co.).

Elmendorf SFH also has a single pair of aluminum raceways that are typically operated as the third-pass serial water use. Each raceway is 8 feet wide and 90 feet long with 78 feet available for fish culture between the inlet and outlet screens. These raceways are 4 feet deep but are typically operated with 3 feet of water depth, which yields an available fish culture volume of 1,900 ft^3. Water used in the second-pass raceways flows to a pump station that uses vertical turbine pumps to supply water to open degassing columns at the head of the aluminum raceway pair. In addition to the reuse water supply there is also a hot water supply to these third-pass raceways.

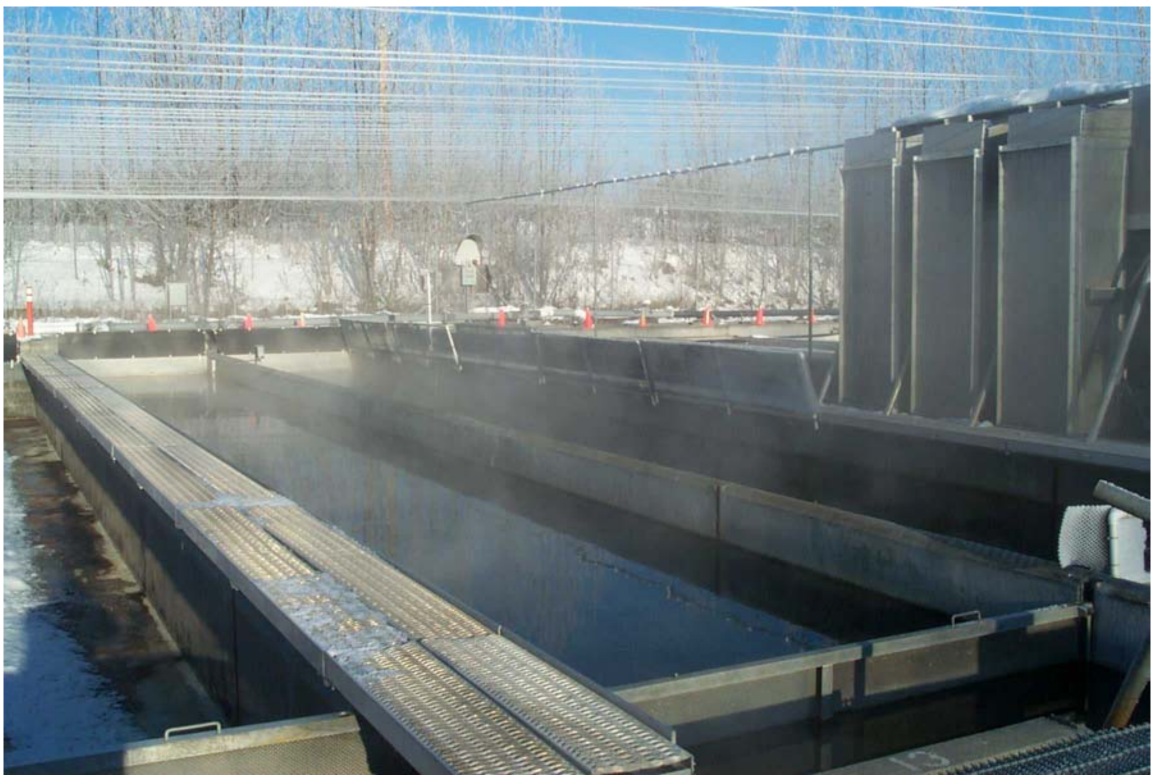


Figure 18. 10 feet wide and 68 feet long concrete raceways (1,800 ft^3 of culture volume)

Figure 19. Vertical turbine pumps and degassing columns for the second-pass raceways

Figure 20. Third-pass aluminum raceways with degassing columns in the background

Biological Production

Chinook Salmon Smolts

Over one million chinook salmon eggs are collected from broodstock in late July at egg take locations on Ship Creek, Crooked Creek, Ninilchik River, and Eklutna Tailrace. The eggs are incubated at Elmendorf SFH in the incubation system until November 1. The chinook salmon fry are then ponded in the outdoor raceways and grown to 14 g smolts by late May. These 0-check smolts are stocked in May and early June. In 2002 a total of 1.115 million chinook salmon smolts will be stocked according to the following:

Release Site	Number	Origin of Broodstock
Ship Creek	315,000	Ship Creek
Seward Lagoon	105,000	Ship Creek or Crooked Creek
Lowel Creek	105,000	Ship Creek or Crooked Creek
Crooked Creek	105,000	Crooked Creek
Homer Split	200,000	Ninilchik River
Halibut Cove	90,000	Ninilchik River
Seldovia	90,000	Ninilchik River
Eklutna Tailrace	105,000	Eklutna Tailrace

Rainbow Trout Catchables

Domestic Swanson River-strain rainbow trout broodstock reared at Fort Richardson SFH are spawned in April of each year yielding approximately 3.1 million eggs. These eggs are incubated and hatched at Fort Richardson SFH producing both diploid and triploid fish. In late August Elmendorf SFH receives approximately 260,000 of the Swanson River-strain rainbow trout from Fort Richardson SFH at a mean size of 2–4 g. The fish are initially ponded in five outdoor raceways and subsequently split and raised in 11 of the outdoor raceways to a mean size of 125 g (all but 10% are larger than 80 g). Over the growing season these fish are graded and split into separate raceways and 10% of the low-growth fish are culled. In May and June they are stocked in two distinct phases. In 2002 a total of 164,000 Swanson River strain mixed sex rainbow trout catchables will be stocked into various landlocked lakes and 95,000 Swanson River strain triploid rainbow trout catchables will be stocked into various lakes and streams.

The current month-to-month biological production plan for the chinook salmon smolt and rainbow trout catchables programs is detailed in Table 2. The current bio-plan at Elmendorf SFH takes places over a single year with a short break in July for hatchery clean-up before restarting in late July. The maximum yearly water use of 7,500 gpm occurs from April to June. The bio-plan stocking schedule for the raceways is shown in four distinct phases in Figure 21. This figure shows that the chinook salmon smolts are reared in the first-pass raceways using blended warm water and that the rainbow trout catchables are reared in the second and third-pass raceways using a mix of warm water and hot water. Table 2 breaks out the flow use for each set of raceways and the serial water-reuse flowrates.

Month	Program	Location	Flow (gpm)	2nd Use (gpm)	3rd Use (gpm)	Rearing Temp. (ºC)	Ship Creek Temp. (ºC)
July	Chinook salmon broodstock	Broodstock raceways	2500			10.2	10.2
	Chinook salmon eggs	Incubation system	150			4–11	
August	Coho salmon broodstock	Broodstock raceways	2500			9.8	9.8
	Chinook salmon eggs	Incubation system	150			4–11	
	Rainbow trout catchables	Raceways (5)	3500	1000		14	
September	Coho salmon broodstock	Broodstock raceways	2500			8.2	8.2
	Chinook salmon eggs	Incubation system	150			4–11	
	Rainbow trout catchables	Raceways (5)	3500	1000		14	
October	Chinook salmon fry	Incubation system	150			4–11	3
	Rainbow trout catchables	Raceways (5)	3500	1000		14	
November	Chinook salmon smolt	Raceways (6)	3000			11	1
	Rainbow trout catchables	Raceways (5)	3500	1000		14	
December	Chinook salmon smolt	Raceways (6)	3000			11	0.5
	Rainbow trout catchables	Raceways (5)	3500	1000		14	
January	Chinook salmon smolt	Raceways (6)	3000			10	0.5
	Rainbow trout catchables	Raceways (8)	3500	1600		14	
February	Chinook salmon smolt	Raceways (10)	6000			7.5	0.5
	Rainbow trout catchables	Raceways (11)		5800	1600	11–14	
March	Chinook salmon smolt	Raceways (10)	6000			7.5	3
	Rainbow trout catchables	Raceways (11)		5800	1600	11–14	
April	Chinook salmon smolt	Raceways (10)	6000			7.5	4
	Rainbow trout catchables	Raceways (11)	1500	5800	1600	10–14	
May	Chinook salmon smolt	Raceways (10)	6000			7.5–8.5	7
	Rainbow trout catchables	Raceways (11)	1500	5800	1600	10–12	
June	Chinook salmon smolt	Raceways (10)	6000			7.5–10	8.9
	Rainbow trout catchables	Raceways (11)	1500	5800	1600	10–12	

Table 2. Current month-to-month biological production plan for Elmendorf SFH

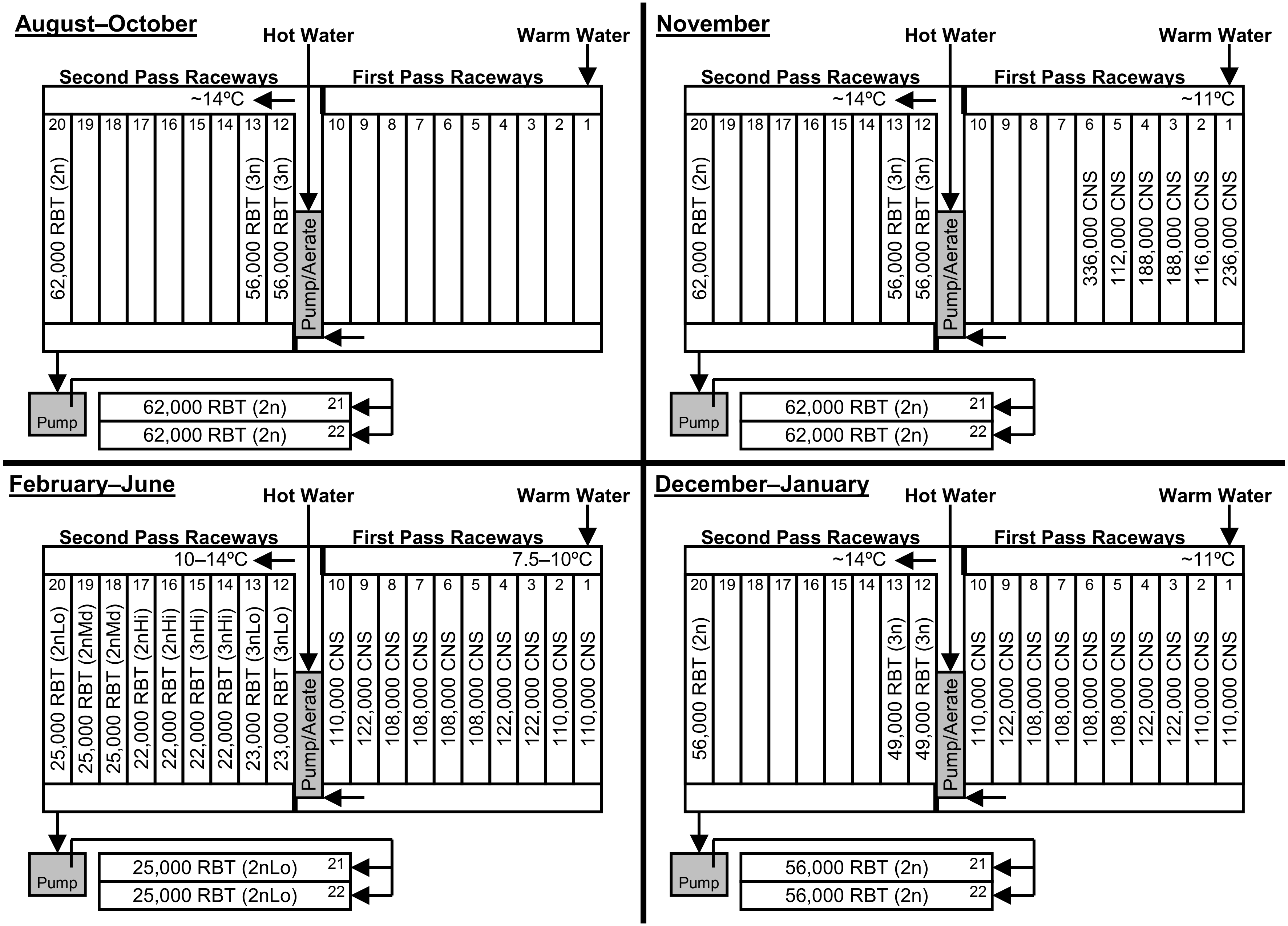


Figure 21. Raceway stocking schedule: RBT=catchable rainbow trout, CNS=chinook salmon smolt, 2n=diploid, 3n=triploid, Lo=low grade, Md=medium grade, Hi=high grade

Fish Health

Elmendorf SFH is not considered a disease-free station because it uses raw Ship Creek water. Ship Creek has active salmon runs and presents the potential for fish pathogen transfer from wild fish to hatchery fish or the introduction of fish pathogens endemic to the area. This is in contrast to Fort Richardson SFH, which uses only well water to prevent the introduction of pathogens through the water supply.

Chronic gas bubble trauma (GBT) has been identified as the main fish health issue at Elmendorf SFH. TGP levels in the blended warm water supply are typically 110% of saturation. Prior to 2000 treatment in open aeration towers with splash screens reduced the TGP levels to 101.5%. While these reduced TGP levels are sufficient for fish culture they resulted in chronic low level stress for the fish. This chronic stress was identified as the cause of fin erosion and a pre-disposition to infections. In 2000 Elmendorf SFH installed new vacuum degassers to address this problem of chronic stress from low levels of TGP supersaturation. Currently the new vacuum degassing treatment seems to have alleviated any GBT problems and secondary bacterial infections from *Aeromonas salmonicida* (furunculosis) and *Renibacterium salmoninarum* (BKD).

Pathogens of Concern

Past history of disease

In the past Elmendorf SFH had significant fish mortalities of 25–30% per year from furuncolosis and BKD. This was attributed to secondary infections from chronic stress due to low levels of TGP supersaturation when adequate degassing was not installed. However, there have been no significant fish disease problems since the new vacuum degassing units were installed in 2000.

Minor infections

Fish reared at Elmendorf SFH have had minor parasitic infections from *Gyrodactylus*, *Trichodina*, *Costia*, and occassional myxobacterial infections. Also, *Saprolegnia* fungus is a minor problem during egg incubation.

Biosecurity Protocols

Treatment

Eggs from on and off-site egg takes are disinfected with iodophors after fertilization. During incubation eggs are treated with formalin prophalactically to control growth of *Saprolegnia*. Formalin treatments are 15 minutes at 1,667 ppm. Once the eggs reach 400 accumulated temperature units formalin treatments are stopped. Elmendorf SFH has tried using hydrogen peroxide for fungus control in the egg incubation system but found that it did not work adequately. Their results indicated that once a fungus growth had started, hydrogen peroxide could not penetrate the fungus and stop the growth.

Chinook salmon smolt and rainbow trout catchables in the raceways are treated for *Gyrodactylus* infections one to two times every spring with formalin at a concentration of 1:6,000 (167 ppm). Other protozoans are also treated with formalin and antibiotics are used in the feed when necessary to control bacterial infections.

Quarantine periods

Both adult salmon broodstock and fingerling rainbow trout from off-site are held or reared at Elmendorf SFH. Adult chinook and coho salmon swimming up Ship Creek in July are caught at the fish trap near the hatchery and moved to the broodstock raceways. These fish are isolated from the main hatchery and raceway area. The rainbow trout catchables (2–4 g) received from Fort Richardson SFH in late August are not quarantined. Culture water used for these fish is not reused for the chinook salmon smolt program.

Equipment disinfection

Nets are disinfected with betadine when used between different stocks of fish.

In July of each year when the hatchery is completely depopulated of fish in the raceways, all head boxes, water intake pipes and sumps, and degassing building equipment, pipes and sumps are cleaned and disinfected with chlorine. The chlorinated wash water is neutralized with sodium thiosulfate and tested to ensure complete neutralization before being discharged.

Staff disinfection

Footbaths were previously in place but their used has been discontinued.

Vector mitigation and culture units covering

The outdoor raceways have been covered with hanging steel wires approximately every 12 inches to prevent diving bird predation (Figures 18 and 19). However the raceways are not fully covered with gill netting that would prevent perching bird predation (e.g., black-billed magpies). Hatchery staff have noted that the magpies do not seem to prey on live fish and mainly eat dead fish from the end of raceways and spilled fish feed on the ground.

Mink have been known to enter the raceways but this is apparently a cyclic and only occasional event.

Effluents

Effluent Quality

Discharge Permit

Elmendorf SFH operates under the State of Alaska Department of Environmental Conservation (DEC) Wastewater General Permit No. 9640-DB005. Elmendorf SFH's authorization for effluent discharge under this permit (Authorization No. 9640-DB005-201) was issued March 13, 1998 and expires March 1, 2003. Elmendorf SFH is authorized to discharge into Ship Creek up to 8,000 gpm from Discharge Number 1, 4,000 gpm from Discharge Number 2, and 3,000 gpm from Discharge Number 3. Discharge Number 1 is the primary hatchery discharge from the settling pond to Ship Creek. Discharge Number 2 is the discharge from the first-pass raceways directly to Ship Creek that is used from October to December. Discharge Number 3 is the discharge from the broodstock holding raceways directly into Ship Creek that is active only from June to September. The discharge permit also has effluent limitations and monitoring, which are presented in Table 3:

Effluent Parameter	Effluent Limitation		Monitoring Requirements	Sample Type
	Monthly Average	Daily Maximum		
Flow	Report	—	Monthly	Estimate/Meter
TSS	5 mg/L	15 mg/L	Monthly (normal) Monthly (cleaning)	Composite Composite
Settleable Solids	—	0.2 mL/L	Monthly (normal) Monthly (cleaning)	Composite Composite
pH	6.5–8.5	—	Monthly	Grab

Table 3. Discharge permit effluent limitations and monitoring requirements

Normal samples for TSS and settleable solids are composite samples, consisting of at least four grab samples at two hour intervals during normal hatchery operating hours. Composite samples collected during cleaning events are taken differently based on the type of discharge. For discharges directly from raceways TSS composite samples consist of four grab samples taken at evenly spaced intervals over the cleaning event. Settleable solids samples consist of two samples collected at least one hour apart during the cleaning event. For discharges from settling ponds TSS and settleable solids samples consist of a single grab sample taken immediately following a cleaning event. Net difference values may be used to meet parameter limits if influent and effluent sampling is conducted and reported. Sampling for the discharge permit is only required from May through October.

Thermal discharge is not listed in the Alaska DEC discharge permit. Thermal profiling within Ship Creek has been performed below the Fort Richardson Military Reservation power plant and

Fort Richardson SFH discharge points. In March nearly all of the Ship Creek flow diverts through the Elmendorf Air Force Base power plant or the Elmendorf SFH. The power plant heats the majority of this flow to 20–21ºC and when it recombines with the 14ºC hatchery water this discharge can represent nearly all of the water flowing in Ship Creek. This water is considerably warmer than typical Ship Creek conditions during July. Therefore, there is some concern that the thermal discharge has changed conditions within Ship Creek.

Discharge monitoring reports (DMR)

Results of the monthly effluent monitoring are filed with the Alaska DEC using DMR reporting forms. Under the current discharge permit Elmendorf SFH has filed DMRs for May, June, July and August 2001. The results of the DMR reporting are presented in Table 4.

	Flow (gpm)	**TSS (mg/L)**	**Settleable Solids (mL/L)**	**pH**
May 2001	7500	2.0	None	7.53
June 2001	7500	2.6	None	6.79
July 2001	No Discharge in July			
August 2001	2500	1.2	None	7.42

*Cleaning flow data was not reported

Table 4. Effluent DMR reporting data for May–June 2001

Contact for DEC Permitting

Tim Wingerter
Alaska DEC, Watershed Management
610 University Avenue
Fairbanks, AK 99709-3643
(907) 451-2116

Wastewater Treatment

Solids Collection

Solids are flushed from the raceway quiescent zones through a collected quiescent zone pipe that discharges to the settling pond. The raceway primary discharge flows to the same settling pond in separate pipes for the first-pass, second-pass, and third-pass raceway systems. If all concrete raceways are operated in parallel their effluent can be discharged in a separate pipeline directly to Ship Creek (Discharge Number 2). This discharge is only utilized by the first-pass raceways from October through December, when the second and third-pass raceways are not in use.

Settable solids are captured in the settling pond and the settling pond has not been cleaned out in at least 21 years. The settling pond overflows into Ship Creek (Discharge Number 1).

The aluminum broodstock raceways discharge directly into Ship Creek (Discharge Number 3), but the broodstock are not fed during this period.

Disinfection/Treatment flows

The only chemical used regularly is formalin. Formalin use for fish occurs from June through mid-September and eggs are treated from July to August. Flows containing formalin are not separated from the primary discharge flow.

Antibiotics are occasionally used in the fish feed. Chlorine used for facility disinfection in the summer is neutralized prior to discharge.

Mortality Collection and Disposal

Fish mortality are bagged and disposed of in an on-site dumpster for final disposal in the local landfill. After spawning dead broodstock are given to a local zoo, dog mushers, and local school science classes for dissection.

IDENTIFIED NEEDS AND RECOMMENDATIONS

1. PREPARATION FOR A SHIFT IN PRODUCTION WHEN FORT RICHARDSON SFH LOSES ITS HEATED WATER SUPPLY

DESCRIPTION

In September of 2003 the Fort Richardson Military Reservation power plant will be decommissioned as the reservation shifts to a decentralized heating system to achieve better overall energy efficiencies. This transition will result in the loss of the waste heat water supply for Fort Richardson SFH. This will have significant impacts for the current biological production in place at Fort Richardson SFH. It is estimated that Fort Richardson SFH withdraws 270 billion BTU per year in heat from the power plant heated effluent and replacement of this heat using a natural gas fired boiler system would cost $1.35 million per year in fuel costs alone. Because of the impending loss of heat at Fort Richardson SFH it has been suggested that all anadromous fish production be shifted to Fort Richardson SFH while all catchable fish production is shifted to Elmendorf SFH.

RECOMMENDATION

The companion evaluation for Fort Richardson SFH identified four options that would allow the Alaska DF&G biological production goals to continue to be met. These recommended options are:

- Shift in production from Fort Richardson SFH to Elmendorf SFH and develop a fish production plan for Fort Richardson SFH that requires little heated water and best utilizes the available cold ambient water supply **AND** retrofit Fort Richardson SFH's indoor raceways to partial-reuse systems and install a new gas-fired boiler to heat only the makeup water flow requirements to meet fry production goals.

- Shift in production from Fort Richardson SFH to Elmendorf SFH and develop a fish production plan for Fort Richardson SFH that requires little heated water and best utilizes the available cold ambient water supply **AND** install modular and separate recirculating systems at Fort Richardson SFH as needed to meet production goals without heated water from the power plant and with less reliance on Elmendorf SFH.

- Replace the Fort Richardson power plant heated water source with heated water from the M. L. and P. Sullivan power plant.

- Abandon Fort Richardson SFH and build a new state-of-the-art fish hatchery.

The first two options require that Elmendorf SFH transition from its current biological production plan. Table 5 presents the recommended overall shift in production between Fort Richardson and Elmendorf SFH required if either of the first two options are implemented.

Table 5. Shift in fish production proposed for Fort Richardson and Elmendorf hatcheries in order to accommodate the closing of the Fort Richardson power plant in September of 2003

Species and life stage	Present Location	Proposed New Location
Rainbow Trout Broodstock	Broodstock Raceways @ Fort Rich SFH	New Recirc Building @ Fort Richardson SFH
Chinook Salmon Smolts	Raceways @ Fort Rich and Elmendorf SFH	Broodstock Raceways @ Fort Richardson SFH
Rainbow Trout Catchables	Raceways @ Fort Rich and Elmendorf SFH	Raceways @ Elmendorf SFH only
Chinook Salmon Catchables	Raceways @ Fort Richardson SFH	Raceways @ Elmendorf SFH
Arctic Char Catchables	Raceways @ Fort Richardson SFH	Raceways @ Elmendorf SFH
Arctic Grayling Catchables	Raceways @ Fort Richardson SFH	Raceways @ Elmendorf SFH
Coho Salmon Smolts	Raceways @ Fort Richardson SFH	No change
Coho, chinook, and rainbow trout fry production (to 4 g)	Indoor raceways @ Fort Rich SFH (except for some Chinook salmon at Elmendorf SFH)	Remain @ Fort Rich SFH in new or retrofitted systems in the Indoor Raceway Building

FEASIBILITY

Implementation of the recommended shift results in all catchable fish being produced at Elmendorf SFH. The current chinook salmon (120,000), arctic char (50,000), and arctic grayling (50,000) catchable fish programs at Fort Richardson SFH amounts to a total production of approximately 220,000 fish per year. Elmendorf SFH will have to add these programs onto its existing rainbow trout catchables production of 260,000 fish per year. The addition of the chinook salmon, arctic char, and arctic grayling catchable programs will likely completely displace the 1.115 million chinook salmon smolt currently produced at Elmendorf SFH. These chinook salmon smolts would be shifted to Fort Richardson SFH. However, beyond displacing the chinook salmon smolt program, the shift in production is feasible and takes advantage of the waste heat water supply at Elmendorf SFH and the close proximity of the two hatcheries. The infrastructure and manpower to accommodate this shift in production is already available at Elmendorf SFH. However, equipment and manpower for stocking will need to be adjusted.

Benefits

The shift of all catchable fish production to Elmendorf SFH takes advantage of the heated water supply available at Elmendorf SFH. This allows the continued production of the accelerated growth catchables for all species currently in production. This accelerated growth catchable product has had a very high success rate in terms of angler satisfaction and continuing this program is only practically achievable at Elmendorf SFH utilizing its source of heated water.

Obstacles

In this proposed production shift between the hatcheries, Elmendorf SFH's one-year (0-check) chinook salmon smolt production will no longer be achievable. The additional catchables production at Elmendorf SFH will require the heated water flow and raceways where the chinook salmon smolts were reared. Moving the chinook salmon smolt program to Fort Richardson SFH will result in the loss of the one-year smolt because of the colder rearing temperatures after the loss of heated water at that hatchery. This program will then become a two-year (1-check) smolt program. A two-year old smolt program mimics the natural life cycle of the chinook salmon and the resulting returns from this stocking product are not likely to decrease in comparison to the one-year smolt. However, depending on when production is shifted from Elmendorf SFH to Fort Richardson SFH there could potentially be a year with no chinook salmon smolts for stocking. This part of the shift in production will have to start a year earlier to maintain a cohort of chinook salmon smolts for stocking the year immediately after the shift occurs.

Costs

The costs associated with the proposed shift in production are minor since this recommendation takes advantage of the existing waste heat water supply at Elmendorf SFH. There may be increases in the operating costs associated with the catchables program versus the one-year smolt program, especially in feed costs. However, any increased cost at Elmendorf SFH will have a corresponding decrease in cost at Fort Richardson SFH and operating funds should be allocated to reflect the change.

2. UPGRADED OFFICE AND EGG INCUBATION FACILITIES

DESCRIPTION

The current office and crew room space are not adequate or safe given that formalin is actively used within the same building and air space. Prophylactic formalin treatment of eggs in the incubation system occurs from July to October. Standard formalin treatments for the control of fungus utilize relatively high formalin concentrations (1,667 ppm) for 15 minutes. Formalin is a respiratory irritant and human carcinogen that must be handled carefully and presents a potential health hazard to the staff at Elmendorf SFH.

In addition, the incubation system needs to be upgraded to provide more reliable temperature mixing using separate well water and warm water head tanks that would provide a constant head to the mixing valve. The current configuration uses a force main from both water sources that results in inconsistent mixing valve operation.

RECOMMENDATION

Formalin use should be reduced or eliminated. To reduce formalin use in the incubation system, egg incubation could be moved into large hatching jars (bulk incubators) where dead eggs could be removed simply and fungus reduced to the point that formalin treatment may not be required during the early stages of incubation. Eggs would be incubated in the jars until the eye-up stage. After the eye-up stage, the eggs would be transferred to standard Heath hatching trays. This recommendation could be implemented with single pass water use or with a water recirculation hatching system. Water recirculation would employ UV irradiation to assist in reducing fungus problems. Reported UV doses for the control of fungus (*Saprolegnia* sp.) vary widely with 10,000 $\mu Ws/cm^2$ reported for inactivation of the hyphae life stage, 35,000 $\mu Ws/cm^2$ reported for the inactivation of the zoospore life stage, and 230,000 $\mu Ws/cm^2$ reported to inhibit the growth of hyphae (Lawson, 1995; Wedemeyer, 1996).

The reduction of formalin use by employing bulk incubators and water recirculation will not eliminate formalin use altogether and provisions for continued formalin use should be considered. It is recommended that the office, crew room, and rest room space be separated from the egg incubation system. At a minimum this separation should be two fold: a physical barrier and separate HVAC systems that keep the two air spaces from mixing. Ideally the egg incubation system would be moved to a separate facility. Because Elmendorf SFH only incubates one batch of eggs a year this separate facility could be a trailer that is used only part of the year. The current egg incubation capacity of Elmendorf SFH could easily be moved into a standard trailer that would contain the hatching trays or jars and process control equipment.

Overall there are three options to reduce formalin use and provide a safer working environment:

Option A: Utilize bulk incubators and Heath stacks in flow-through water use
Option B: Utilize bulk incubators and Heath stacks in a water recirculation system
Option C: Move the egg incubation facilities to a separate trailer

Feasibility

It is recommended that **Option A** or **Option B** be combined with **Option C** to provide the highest benefits.

Option A: Installation and use of bulk incubators could be done in the current incubation and hatching area. This would be a temporary installation until the eggs are transferred to Heath stacks for the remainder of the incubation period. The bulk incubator installation would require influent water piping from the existing head tanks to the incubators and drain piping to the existing drains. Incubation of 1.115 million chinook salmon eggs would require a minimum of six 8 inch diameter, 36 inch tall bulk incubators. Each incubator is capable of incubating a maximum of 200,000 salmon eggs. At a water flow of 7–8 gpm for each incubator, the total required minimum flow is 48 gpm.

Option B: Water reuse for egg incubation is a proven successful technology that is employed at both public and private cold water hatcheries. A 40–50 gpm recirculating egg incubation system is shown in Fig. 22 with the capacity for 10 stacks (only 2 stacks shown installed). This system uses backup chillers and pumps for redundancy and screen filtration and UV treatment to minimize maintenance labor. Installation of two recirculating incubation systems at Elmendorf SFH could be done in the current incubation and hatching area and use the existing Heath stacks (9–10 stacks per system) and influent piping, but new drain piping may be necessary. Chillers would not likely be required for Elmendorf SFH, but effective temperature control within the system would be.

Option C: The separation of the office, crew room, and rest room space from the egg incubation and hatching facilities is best accomplished if the egg incubation facilities are moved to a trailer. Public and private facilities are employing trailer-based egg incubation and hatching for a variety of reasons including minimizing the formalin hazard to staff and the flexibility of being able to move the incubation and hatching facilities to other locations. Trailer-based egg incubation and hatching can include the process equipment if it is a recirculating incubation system in the same trailer or a smaller, adjacent "process trailer". Both jar-based and tray-based incubation systems can be housed in a trailer. If the current incubation and hatching equipment is moved to a separate trailer then water supply and drain lines must be installed to and from the trailer.

Benefits

Option A: The use of bulk incubators in either flow through water use or a water recirculation system will provide benefits in better dead egg removal, and thus less fungal growth and lower formalin use.

Option B: A major benefit to utilizing water recirculation for egg incubation is the reduction in water use. This also reduces the total flow that would have to be treated if effluent treatment was mandated to prevent the spread of pathogens from the facility. Another benefit to water recirculation is the reduced use of formalin due to solids filtration and UV treatment. Individual water recirculation systems also allow for tight temperature control on egg incubation. This would work well when tailoring a batch of eggs to a developmental index and hatching time.

<u>Option C</u>: The major benefit to the separation of the egg incubation facilities from the office, crew room, and rest room space is a safer working environment in those high traffic areas. Additionally, a movable trailer would allow for the incubation and hatching equipment to be moved for use elsewhere.

Costs

<u>Option A</u>: Bulk egg incubators cost $520 each giving a cost for six incubators of $3,120. This option would also require piping modifications if the incubators were installed in the space next to the existing Heath stacks. It is anticipated that these modifications would be done in-house for a cost of approximately $500–$1,000. The total cost of implementing this option is expected to be $5,000.

<u>Option B</u>: If the existing incubation and hatching system was converted to water recirculation then additional process components (pumps, pressure sand/screen filters, UV units) would be required and recirculation piping installed. The total estimate for installing the new process equipment and piping for two separate recirculating modules (9 stacks each) is $25,000.

<u>Option C</u>: The cost estimate for a trailer, modifications to the trailer, and associated influent/effluent piping is a total of $50,000. This assumes that the existing Heath stacks would be used in the trailer.

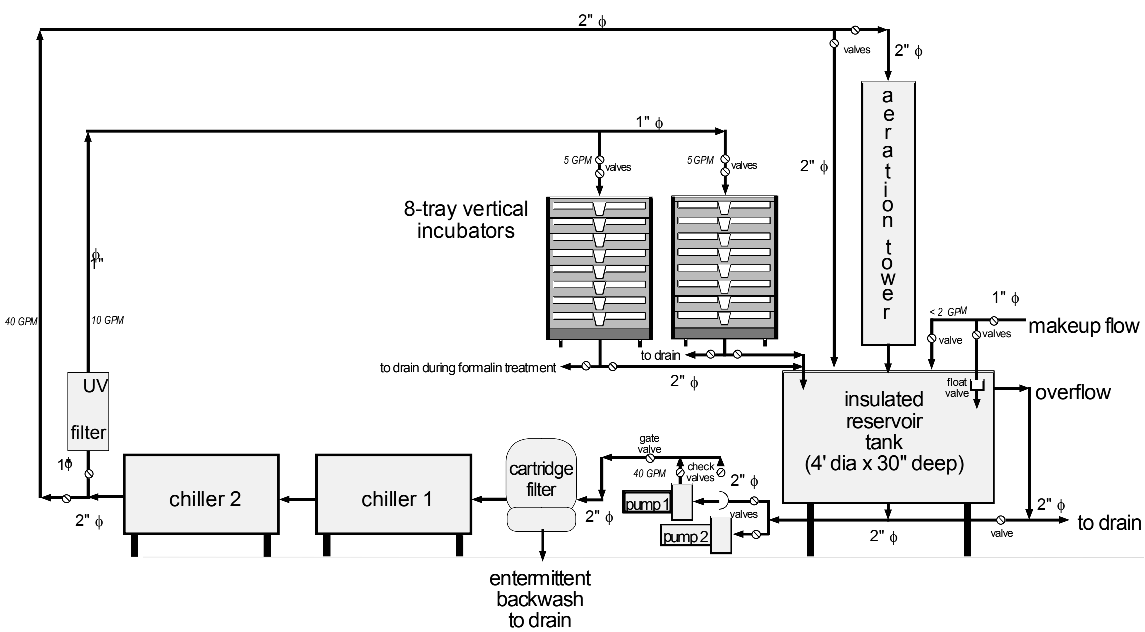


Figure 22. Recirculating egg incubation system for 10 stacks or 40–50 gpm. This system includes chillers and pleated cartridge screen filtration of the full flow. UV filtration is only required for the water sent to the hatching stacks.

3. Upgraded facilities for fish passage, public viewing, education, and outreach

Description

There are insufficient facilities for public viewing, education, and outreach opportunities to fully take advantage of Elmendorf SFH's unique location. Elmendorf SFH is located within Alaska's largest population center on the second largest recreational fishery in Alaska. Its easily accessible location in Anchorage situated on Ship Creek presents a unique opportunity for public viewing, education and outreach. The current kiosks are functional only at a basic level. In addition, indications are that the current fish ladder at the intake water dam is inoperable. The first part of the ladder is steep and access to the entrance is limited to a small area. Also, the overflow heated water outfalls at the fish ladder entrance, which may be a deterrent for fish approaching the fish ladder entrance.

Recommendation

It is recommended that education and outreach opportunities at Elmendorf SFH be maximized through the construction of a public outreach center that would include fishway viewing and a visitor/education center to accommodate 40–45 people. The location of Elmendorf SFH in an urban setting is a unique opportunity to easily reach out to a large population base and provide education about the natural aquatic environment, Pacific salmon, and the activities of the Alaska DF&G to conserve these natural resources.

The construction should include an upgrade or replacement of the current fish ladder at the intake water dam. Reconstruction of the fish ladder should address:

- improved fish access to the ladder entrance;
- better overall fish passage;
- a new location for the heated water overflow outfall;
- public viewing;
- integration of the physical fish ladder structure into the Ship Creek natural setting

The 14.2 ft high sheet-pile dam at Elmendorf SFH for diversion of water to the Air Force Base power plant and the hatchery is the second major barrier to fish passage on Ship Creek. Without an operating fish ladder the current dam blocks salmon from passing further upstream to spawn. We recommend that this issue be addressed and incorporated into the education and outreach component.

Feasibility

Reconstruction of the fish ladder and new construction of a public outreach/education center is a major effort. Implementation of this recommendation will require support from the community and the Department of Fish and Game. On the conceptual level this is a feasible task given the available space and known physical constraints of the property near the existing dam. The outreach/education center should emphasize the fish ladder, fish passage, and the efforts of the Department of Fish and Game's stock enhancement and sport fish management program. An estimate of the size of this center is 50 ft by 50 ft and would include educational displays, kiosks, and a small presentation room. There should be a walkway leading to the fish ladder viewing area.

The area where the current fish ladder and ladder viewing area are could be reconstructed to incorporate a fish ladder like the one shown in Figure 23. The fish ladder at the Saint-Ours Dam in Canada has excellent public viewing. This vertical slot fish ladder has 16 pools that are 10 ft by 11.5 ft with 0.5 ft of head between the pools.

Figure 23. Fish ladder at the Richelieu River's Saint-Ours Dam in Canada (©2002 St Lawrence Vision 2000.)

The potential of the salmon runs in Ship Creek likely requires a fish ladder of a larger size than what is currently in place. Clay (1995) has indicated that for adult salmon over 2 pounds the minimum individual pool size for a vertical slot fish ladder is 6 ft wide by 8 ft long and 2 ft deep. The head difference between each pool should be 1 ft with a vertical slot opening of 1 ft. Other important criteria for fish ladders for Pacific salmon are presented in Table 6. A conceptual design for the new fish ladder at Elmendorf SFH would include 14 pools that are 6 ft wide, 8 ft long and 2 ft deep (minimum) with a head difference of 1 ft between each pool. The ladder could be built on the bank of Ship Creek in an S-configuration.

Design Criteria	Value
Entrance Water Velocity	4–8 ft/s
Entrance Depth	1.6–4 feet
Head Difference between Pools	1 ft
Space Required for Fish	0.2 ft^3/lb
Max Water Velocity in Slots or over Weirs	8 ft/sec
Water Velocity for Diffusion Gratings	0.25–0.5 ft/sec

Table 6. Fish ladder design criteria for Pacific salmon (Clay, 1995)

Benefits

The primary benefits to the construction of an outreach/education center are for the public through increased education and awareness of the natural aquatic environment, the Pacific salmon, and the efforts of the Alaska Department of Fish and Game. However, Elmendorf SFH and the Department of Fish and Game will also benefit as the public gains a better understanding of the hatchery's role and the benefits it provides. Construction of a new fish ladder will allow fish to pass the dam at Elmendorf SFH and migrate upstream to utilize more of Ship Creek for spawning habitat.

Obstacles

There does not appear to be any major obstacles to the construction recommended based on current knowledge of the site. Construction of the fish ladder on the creek bank will require considerable structural investigation and modifications to the existing landscape.

One important consideration is the water flow required for proper fish ladder operation. Utilizing a velocity criteria of 8 ft/sec in the vertical slots (1 ft wide and 2–4 ft deep) connecting the pools results in 16–32 cfs of water required for proper fish ladder operation. Additionally, a velocity of 4 ft/s is required for attracting fish to the fish ladder entrance.

Costs

The conceptual cost estimate for construction of the outreach/education center and new fish ladder follows:

Item	**Quantity**	**Unit Cost**	**Cost**
Outreach Center Construction	2,500 ft^2	$250/$ft^2$	$625,000
Outreach Center Site Preparation	5,000 ft^2	$10/$ft^2$	$50,000
Excavation for Fish Ladder	10,000 ft^3	$10/$yd^3$	$4,000
Rock Removal Allowance	1	$100,000	$100,000
Fish Ladder Construction*	3,360 ft^3	$72/$ft^3$	$242,000
Fish Ladder Appurtenances	29%	$242,000	$71,000
Electrical	7.5%	—	—
Miscellaneous Labor	5%	$1,092,000	$55,000
Sub-total			$1,147,000
Design and Construction Admin.	15%	$1,147,000	$173,000
Contractor Overhead/Profit	25%	$1,147,000	$287,000
Contingency	10%	$1,147,000	$115,000
TOTAL			**$1,722,000**

*Cost based on $40/$ft^3$ in 1987 dollars (Clay, 1995) and adjusted using 4% inflation per year

4. Develop an effluent treatment and solids management plan to meet EPA's new guidelines for flow through salmonid hatcheries

Description

The U.S. EPA is currently developing guidelines for the regulation of effluent from aquaculture facilities, including state operated serial water-reuse hatcheries like Elmendorf SFH. The U.S. EPA will be proposing its initial regulation in June of 2002, which will likely include best management practices (BMPs) for effluent treatment that serial water-reuse hatcheries will need to adhere to for compliance.

Recommendation

Elmendorf SFH should develop a complete effluent treatment and solids management plan to meet the U.S. EPA's new guidelines for serial water-reuse salmonid hatcheries. This plan should address the newly proposed BMPs and also consider minimizing the impact that the Elmendorf SFH discharge has on Ship Creek.

Option A: BMPs for serial water-reuse salmonid hatcheries may only require full-flow settling basins and directing the quiescent zone cleaning flow to an off-line settling basin. In this case the minimum that Elmendorf SFH will have to do is reconfigure their settling pond into two separate basins: one for the primary discharge and one for the quiescent zone cleaning flow. However, it is recommended that if changes to the settling pond are required that new basins be constructed and engineered for improved settling and simple and frequent solids removal. Additionally, it is recommended that duplicate basins be created to allow one basin to be taken off-line for decanting, solids thickening, and solids removal, while effluent treatment continues in another identical basin. This recommendation applies to both full-flow and off-line settling basins.

Option B: BMPs for serial water-reuse salmonid hatcheries may require microscreen filtration in addition to directing the quiescent zone cleaning flow to an off-line settling pond. In this case it is recommended that Elmendorf SFH implement an effluent treatment design that collects the primary flow and off-line settling basin overflow for treatment in microscreen filters. The backwash from the microscreen filters should be directed to the off-line settling basins or separate solids thickening basins. The microscreen filters should be housed in a water treatment building for protection from the environment. Also, it is recommended that if the off-line settling basins are used for both the quiescent zone cleaning flow and microscreen backwash flow that the basin design account for both process flows.

FEASIBILITY

Elmendorf SFH has three separate effluent discharges defined in their wastewater permit: Discharge Number 1, the primary hatchery discharge from the settling pond to Ship Creek; Discharge Number 2, the discharge from the first-pass raceways directly to Ship Creek that is used from October to December; and Discharge Number 3, the discharge from the broodstock holding raceways directly into Ship Creek that is active only from June to September. In addition to these permitted discharge points, Elmendorf SFH has separate effluent pipelines for the first-pass raceways, the second-pass raceways, the third-pass raceways, and the quiescent zone cleaning flow from the first and second-pass raceways. All pipelines discharge directly into the settling pond. Because the quiescent zone cleaning flow can be directed in its own pipeline, separating this flow from the primary discharge is relatively straightforward.

Option A: Implementing full-flow settling basins would be possible with duplicate full-flow settling basins that each have an effective settling zone 160 feet long, 40 feet wide and 6 feet deep. These basins adhere to a full-flow settling design hydraulic loading of 0.013 $ft^3/ft^2/sec$ with a safety factor of 5, an aspect ratio (L:W) of 4, and a minimum clear well hydraulic retention time of 20 minutes. Three feet of the basin depth is available for solids storage. Additional basin length is required for influent weir area (6 ft) and effluent weir area (9 ft) and 1 ft of freeboard is needed over the water surface yielding overall interior dimensions of 175 feet long, 40 feet wide and 7 feet deep. Utilizing the entire basin width for influent and effluent weir length results in a weir loading rate of 36,000 $ft^3/d/ft$. This rate is within the recommended range for larger solids (32,350–60,160 $ft^3/d/ft$) presented by the Idaho DEQ (1998).

The off-line settling basins should be duplicate basins that each have an effective settling zone 100 feet long, 25 feet wide and 5 feet deep. These basins adhere to an off-line settling design hydraulic loading of 0.00151 $ft^3/ft^2/sec$ with a safety factor of 2, an aspect ratio (L:W) of 4, and a minimum clear well hydraulic retention time of 30 minutes. Three and half feet of the basin depth is available for solids storage. Additional basin length is required for influent weir area (6 ft) and effluent weir area (8 ft) and 1 ft of freeboard is needed over the water surface yielding overall interior dimensions of 112 feet long, 25 feet wide and 6 feet deep. Utilizing the entire basin width for influent and effluent weir length results in a weir loading rate of 6,200 $ft^3/d/ft$. This is slightly above the recommended rate for fine particulates (4,278 $ft^3/d/ft$), but well below the recommended range for larger solids (32,350–60,160 $ft^3/d/ft$) presented by the Idaho DEQ (1998).

Option B: Implementing microscreen filtration would be possible by collecting all hatchery effluent and directing it to three microscreen drum filters in a parallel flow configuration. The required filter screen area per filter is 126.5 ft^2. Each filter would be capable of treating 5,800 gpm at 15 mg/L TSS using 60 µm screen panels or 7,000 gpm at 15 mg/L TSS using 90 µm screen panels. These filters would be contained in a multi-chambered, concrete sump housed within a wastewater treatment building 40 ft by 60 ft in size. Filter operation would be staged as required, with one microscreen drum filter serving as a redundant filter for maintenance purposes.

The off-line settling basins for this option would be the same as for Option A, with basins that each have an effective settling zone 100 feet long, 25 feet wide and 5 feet deep. These basins adhere to an off-line settling design hydraulic loading of 0.00151 $ft^3/ft^2/sec$ with a safety factor of 2, an aspect ratio (L:W) of 4, and a minimum clear well hydraulic retention time of 30 minutes. Three and half feet of the basin depth is available for solids storage. Additional basin length is required for influent weir area (6 ft) and effluent weir area (8 ft) and 1 ft of freeboard is needed over the water surface yielding overall interior dimensions of 112 feet long, 25 feet wide and 6 feet deep. Utilizing the entire basin width for influent and effluent weir length results in a weir loading rate of 6,500 $ft^3/d/ft$. This is slightly above the recommended rate for fine particulates (4,278 $ft^3/d/ft$), but well below the recommended range for larger solids (32,350–60,160 $ft^3/d/ft$) presented by the Idaho DEQ (1998).

Benefits

Developing and implementing a complete effluent treatment and solids management plan will allow Elmendorf SFH to remain in compliance with the U.S. EPA's new guidelines for serial water-reuse salmonid hatcheries. Additionally, any improved efforts to treat the discharge will lessen the environmental impacts of the Elmendorf SFH effluent on Ship Creek. The level of treatment effectiveness with full-flow settling and off-line settling of the quiescent zone cleaning flow will likely only result in an overall TSS removal of 10–30%. Treatment effectiveness utilizing microscreen filtration will result in an overall TSS removal of 30–50%.

Obstacles

Implementing either effluent treatment alternative will likely require the area currently occupied by the existing settling pond. However, the land required for either option is available.

Costs

<u>Option A</u>: Implementation of the combination of full-flow (FF) settling and off-line (OL) settling to treat the primary effluent and quiescent zone cleaning flows will require the reconstruction of the settling basin area. Construction of the basins in concrete to maximize the basin effectiveness results in the following cost breakdown. All costs are rounded up to the nearest $1,000.

Item	**Quantity**	**Unit Cost**	**Cost**
Excavation of FF Settling Basin Area	156,000 ft^3	$10/$yd^3$	$58,000
Excavation of OL Settling Basin Area	65,000 ft^3	$10/$yd^3$	$25,000
Rock Removal Allowance	1	$100,000	$100,000
FF Settling Basin Construction*	2	$350,000/basin	$700,000*
OL Settling Basin Construction*	2	$159,000/basin	$318,000*
Plumbing**	10%	$1,018,000	$102,000
Electrical	7.5%	—	—
Miscellaneous Labor**	5%	$1,018,000	$51,000
Sub-total			$1,354,000
Design and Construction Admin.	15%	$1,354,000	$204,000
Contractor Overhead/Profit	25%	$336,000	$84,000
Contingency	10%	$1,354,000	$136,000
TOTAL			**$1,778,000**

*Includes Contractor Overhead and Profit
**Based on Basin Construction Costs Only

<u>Option B</u>: Implementation of microscreen filtration of all Elmendorf SFH effluent along with the required construction of off-line settling basins to treat the quiescent zone cleaning flow and microscreen filter backwash will also require construction in the area of the current settling pond. All costs are rounded up to the nearest $1,000.

Item	**Quantity**	**Unit Cost**	**Cost**
Treatment Building	2,400 ft^2	$150/$ft^2$	$360,000
Building Site Preparation	4,800 ft^2	$10/$ft^2$	$48,000
Microscreen Filters	3	$32,000	$96,000
Microscreen Filter Sump	1	$51,000	$51,000
OL Settling Basin Construction*	2	$159,000	$318,000*
Plumbing**	10%	$825,000	$83,000
Electrical***	7.5%	$507,000	$39,000
Miscellaneous Labor**	5%	$825,000	$42,000
Sub-total			$1,037,000
Design and Construction Admin.	15%	$1,037,000	$156,000
Contractor Overhead/Profit	25%	$719,000	$180,000
Contingency	10%	$1,037,000	$104,000
TOTAL			**$1,477,000**

*Includes Contractor Overhead and Profit
**Based on Treatment Building, Microscreen Filters, Microscreen Filter Sump, and Basin Construction Costs
**Based on Treatment Building, Microscreen Filters, and Microscreen Filter Sump Costs

5. Preparation for a loss of heated water supply in the event that the Elmendorf Air Force Base power plant is decommissioned

Description

Elmendorf Air Force Base is currently reviewing its power plant for potential upgrade or decommissioning. The decision on the power plant will be made in late 2002. If this review results in the closing of the Elmendorf Air Force Base power plant, Elmendorf SFH would likely lose its source of heated water in 2005. This would have significant impacts on hatchery production and future programming for the Alaska DF&G Sport Fish Division.

Recommendation

Because this issue is somewhat long term it has been considered in terms of two different scenarios:

1. Fort Richardson SFH without a waste heat water supply and with some investment in water reuse technologies (per the accompanying Fort Richardson SFH report).

2. Fort Richardson SFH having been abandoned and a new hatchery constructed that utilizes water recirculation technologies or a source of inexpensive waste heat water supply or both.

In the first case neither Elmendorf SFH nor Fort Richardson SFH will have access to a waste heat water supply. The assumption is that some investment in water reuse technologies has been made at Fort Richardson SFH but no new hatchery has been constructed. Additional demand for 1-check smolts must also be considered in the scenario. If this set of conditions exists and there is no additional demand for 1-check smolts then Elmendorf SFH's function is in question. Elmendorf SFH could convert to fully recirculating water use and use additional well water resources for catchables/fry production. However, this is essentially building a new hatchery at Elmendorf SFH. Instead, we recommend that Fort Richardson SFH be abandoned and the investment in a new hatchery be made at an ideal location. Elmendorf SFH would continue to produce 1-check smolts for nearby stocking sites in a cold water production regime.

In the second case where Fort Richardson SFH has already been abandoned and a new hatchery is being built then we make the same recommendation, that Elmendorf SFH convert to cold water production for 1-check smolts. This will require some facility changes for safe operation of the hatchery in cold water/cold weather conditions. In this situation consideration should be given to partial water reuse technology using well water to provide a more biosecure water supply than currently exists.

FEASIBILITY

Conversion of Elmendorf SFH to cold water production would require the following minimum changes:

- Upgrade of the existing water intake structure to prevent:
  - the intake from becoming clogged with ice flows in Ship Creek
  - anchor ice from forming on the bar rack or traveling screen filter
- Covering the raceways with a basic pre-engineered metal building

Upgrading the existing water intake structure to avoid problems with ice and icing is a considerable project. Prevention of ice from blocking the intake may require the installation of a mechanical bar rack. This type of equipment would allow the removal ice caught in the intake channel or ice forming on the bar rack. This is a feasible alternative but may require a complete reconfiguration of the intake within Ship Creek to be effective.

Covering the raceways with a building is easily accomplished and would prevent the work environment from becoming extremely dangerous. Without a building covering the raceways they would likely have ice form on all surfaces and over the water surface.

An alternative to using unheated Ship Creek water in covered raceways is utilizing partial water reuse technology. This technology could be employed in addition to Ship Creek water or in place of Ship Creek water with a potential change in production. The benefits of a partial water reuse system could be maximized by using well water resources. Elmendorf SFH staff have indicated that up to 1,000 gpm of additional well water resources may be able to be developed on site. A partial water reuse system would be circular tank-based and housed within a building for protection from the harsh environment and for enhanced biosecurity. Water treatment within the system would include solids treatment, carbon dioxide stripping, and oxygenation for maintaining good water quality for fish culture. Assuming a total of 1,000 gpm of well water is available for use in a partial reuse system, then an in-system total water flow of 6,600 gpm could be realized at an 85% reuse rate (5,600 gpm in reuse). Utilizing a hydraulic retention time in the fish tanks of 30 minutes results in a total available culture volume of 198,000 gallons. This could be distributed among twenty 20 ft diameter tanks with 4 ft of water depth. The tanks would be grouped into 4 modules of 5 tanks each. The total reuse flow for each system module would be 1,400 gpm with a makeup flow of 250 gpm. The building required to enclose the fish tanks and process equipment would be approximately 150 ft by 200 ft.

Benefits

Converting to cold water production at Elmendorf SFH would allow the hatchery to produce 1-check smolts and potentially produce arctic char catchables as part of the overall Alaska DF&G stocking plan. However, there are benefits to utilizing partial water-reuse systems at Elmendorf SFH. Partial water-reuse using well water would allow a high level of biosecurity to be maintained and limit the risk from fish pathogens. Also, this would allow the well water resource to be maximized and prevent the problems of ice formation in the fish culture system.

Obstacles

Upgrading the existing water intake structure for reasonable cold weather operation is a potential challenge to implementation of cold water operation of the hatchery. The installation of a mechanical bar rack may require major construction at the intake building, especially if the intake channel has to be reoriented for proper equipment operation.

Costs

The major costs for conversion to cold water production include the modifications to the intake structure and covering the raceways. The cost estimate for changes to the intake structure is \$0.5–\$1 million. Covering the first and second-pass raceways with a pre-engineered metal building 100 ft wide and 220 ft long would cost approximately \$1.1 million. This building cost assumes a unit cost of \$50/ft^2. Additional project costs would be expected resulting in a total cost for cold weather conversion of \$1.75–\$2 million.

The cost of installing the partial water reuse building with all fish tanks and process equipment is estimated at \$4–\$5 million.

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